DIGITAL CHARACTER COSTUME DESIGN IN COMPUTER-ANIMATED FEATURE FILMS

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ABSTRACT

In the production of Hollywood animation, costume designs are traditionally developed as part of character animation where decisions regarding costumes are folded into the phase of character development and as part of the animators' work. For this reason, very rarely do computer-animated films engage a professional costume designer as part of the production process. This doctoral thesis explores how digitally animated costumes are designed and how costumes connect to characters' personalities and narrative in six computer-animated films that have engaged a costume designer in their production. The designers and case study films are Isis Mussenden (*Shrek*, 2001; *Shrek 2*, 2004; and *Puss in Boots*, 2011); Israel Segal (*Shrek the Third*, 2007); Ruth Myers (*Monster House*, 2006); and Danny Flynn (*Big Hero 6*, 2014). The analysis of these examples uncovers the costume designer's important role and contribution in computer-animated film productions on multiple levels.

The analysis of oral records, visual references, costume drawings, key scenes, and characters from the case study films illuminates larger thematic areas relating to the costume designer's role and contribution in computer-animated film production teams. It also shows the effect of animation software development on character costume design, in the creation of the final digitally animated costume, along with the significance of tangible material exploration for digital character costume design. This data-driven study reflects on the theory of somaesthetics and concepts of sensory and haptic perception (Shusterman 1999; Marks 2002), theories on embodiment (Monks 2010; Crafton 2013), as well as tangible and digital materiality (Ingold 2013; Harris 2013), which sharpen our understanding of costume designers' creative processes and the multisensory experiences involved in costume design development and creation, as well as in the spectator's perceptive understanding of the character.

This thesis proposes that costume designers are valuable collaborators within the production of computer-animated films, where their expert knowledge contributes to a character's tighter connection to the action via costume. The costumes in the case study films were created with certain animation software that has influenced the design process and outcome of the final costume design. Digital costumes form the character's body and overall silhouette, which are essential for audience recognition of an animated character. The study demonstrates that tangible materials, such as garments and fabrics, are explored through both tactile and visual methods by costume designers as part of costume design development, and by animators when they create the costumes via software. Tangible material exploration relates to somaesthetic practice, which guides the designers and animators in their work processes.

This research reveals how costume designers' ideas enhance characters' personal identity and lived life through specific design elements, colours, and materials. This makes the digital character costumes transfer multisensorial experiences to the spectators, facilitating their immersion in the world of the film. The costumes accurately replicate real-world materials and physical garment behaviour during character movement, which renders them digitally realistic. This thesis presents ideas and theories to bring awareness of costume design in animation, as costumes play a crucial role in visually representing characters' identities and connection with computer-animated films' narratives.

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CONTENTS

ABSTRACT 4

ACKNOWLEDGEMENTS 6

LIST OF FIGURES 12

INTRODUCTION 23

- Framing the work: aims and research questions 28
- Thesis structure 33

CHAPTER 1 – SETTING UP THE SCENE: COSTUME DESIGN IN ANIMATION 39

- Costume design and character representation 40
- Costumes as visual connectors of narrative 46
- Costume and performance 49
- Drawing and real-life representation 52
- Costume design in the context of computer animation 56
- Conclusion 64

CHAPTER 2 – RESEARCH DESIGN 71

- 2.1 Case study research 72
- 2.2 Research data collection methods 74
  - Archival research 74
  - Interviews 75
  - Research materials 81
- 2.3 Methods for data analysis 82
  - Content analysis 83
  - Visual analysis: visual and audio-visual materials 86
  - Comparative analysis 89

2.4 Theoretical frame: Key concepts and theories employed for the study of digital character costume design 90
Somaesthetics and sensory perception 92
Theories of embodiment 95
Theories on materiality 97

CHAPTER 3 – COSTUME DESIGNERS AS PART OF COLLABORATIVE COMPUTER-ANIMATED FILM PRODUCTIONS 105
3.1 Story development and costume design 109
3.2 Visual materials as part of collaboration 120
Art direction and concept art: the starting point for costume design 120
Texture information in mood boards 127
Storyboards informing story development 129
Costume drawings 131
Character development with maquettes 137
3.3 'Nothing underneath it exists': Absence of the actor in the collaboration 142
3.4 Conclusion 147

CHAPTER 4 – DIGITALLY ANIMATED COSTUMES 155
4.1 Digital costume models 158
4.2 The effect of computer animation software in the design of costumes 169
4.3 The physical condition of a costume tells a narrative 179
4.4 The same, but different: Costume design for the crowds 189
4.5 Conclusion 204

CHAPTER 5 – FROM TANGIBLE MATERIALS TO DIGITAL COSTUMES 209
5.1 Tangible and visual materials as part of costume design development 213
5.2 Two-dimensional patterns turn to three-dimensional digital costumes 228
5.3 Costume in motion 237
5.4 End result: Digital textures 242
5.5 Conclusion 250

CHAPTER 6 – RESEARCH CONCLUSIONS 257
6.1 Limitations of the study 267
6.2 Setting up the future: Return to research ideas and implications of this study for the animation industry 269

REFERENCES 276
Literature 276
Visual references 283
Films 283
Television 284

APPENDICES 285

GLOSSARY 288

LIST OF FIGURES

Figure 1 My cross-disciplinary research is located within the cross-section of costume design and animation. This approach brings new knowledge on digital characters' costume design.

Figure 2 This figure illustrates my research path. From the research problem, questions, and prior understanding of the topic, I selected research methods to collect data, which generated my research materials. Thereafter, I analysed the data by embedding key concepts and theories in the analysis in later stages of my research path, which produced the research results.

Figure 3 Theoretical framing and the relation between key theories and concepts.

Figure 4 Computer-animated feature film production schedule example by Winder and Dowlatabadi (2011) that illustrates the overlapping production phases. Winder and Dowlatabadi (2011: 121).

Figure 5 Israel Segal's costume design suggestion for Shrek in a scene where he and Fiona are presented to the court as regents. His costume ensemble consists of features from different period fashions to enhance comedic appearance and performance. Courtesy of Israel Segal.

Figure 6 Israel Segal's costume design suggestion for Fiona and Shrek in a scene where they are presented to the court as regents. The visual reference for Fiona's dress originates from Velázquez's portrait of Mariana of Austria. Courtesy of Israel Segal.

Figure 7 This image illustrates Fiona's costume in the film, which includes a millstone collar and a white wig, similar to those depicted in Shrek's costume drawing. These have been added to create a more comic physical and visual appearance. Screenshot (cropped) from *Shrek the Third*.

Figures 8–9 Two of Israel Segal's costume design ideas for the cheerleader characters in *Shrek the Third*. The visual inspiration of the height of the Middle Ages was used as a comedic, performative element in the scene. Visible in Figure 8 is the idea of using medieval morning star weapons as pom-poms, which did not end up in the film. Figure 9 shows the hay material as pom-poms, as well as a slightly different cheerleader costume. Courtesy of Israel Segal.

Figure 10 Israel Segal's costume drawings suggest how the cheerleader's medieval steeple headdress could function as a megaphone. Courtesy of Israel Segal.

Figure 11 The style of the conical headdresses was included in the final animation. Screenshot (cropped) from *Shrek the Third*.

Figure 12 Guillaume Aretos' concept art for the production of *Puss in Boots*. His design idea of visually twisting the form of locations and architecture is clearly visible in this concept art example. Image source: Guillaume Aretos' online portfolio www.aretos.com.

Figure 13 Examples of *Monster House*'s art direction by Chris Appelhan. Image source: Chris Appelhan's online portfolio www.froghatstudios.com.

Figure 14 The art director for environments, Scott Watanabe's concept art for the film *Big Hero 6*. Image source: Watanabe's online portfolio www.watanabeart.com.

Figure 15 Concept art by Ryan Lang for *Big Hero 6*. Image source: Ryan Lang's online portfolio www.ryanlangdraws.com.

Figure 16 Israel Segal's costume drawing for *Shrek the Third* represents a quick sketch that mainly illustrates the structure of a garment and specific details with written commentary. Courtesy of Israel Segal.

Figure 17 Isis Mussenden's costume drawing illustrates a more finalised design with details of costume structure. Courtesy of Isis Mussenden.

Figure 18 Isis Mussenden's costume drawing for Princess Fiona in *Shrek 2* is from a costume design development phase and illustrates how costume drawings visualise the design ideas and facilitate discussions to develop the costumes. Courtesy of Isis Mussenden.

Figure 19 One of the very first sculpted maquettes of the character Shrek. Designed and sculpted by Tim Lawrence and Loren Soman. Image source: worthpoint.com.

Figure 20 This figure indicates the costume designers' collaborators, the different professions that are involved in the design of the digital character costume, and the visual and textual materials that are part of costume design.

Figures 21–22 Lord Farquaad's costume change in the film *Shrek* was accomplished by re-using the same costume structure and changing the colours of the costumes. Screenshots (cropped) from *Shrek*.

Figures 23–24 Fiona's two dresses in *Shrek 2* have an identical structure and design, demonstrating that the same costume model was re-used for her costumes. The costume change was executed with different colours; however, in contrast to the previous film, fabric textures enhanced the differentiation of these two costumes. Screenshots (cropped) from *Shrek 2*.

Figure 25 Fiona's dress design in *Shrek*. Screenshot (cropped) from *Shrek*.

Figure 26 Fiona's dress in the final scene in *Shrek 2* has been made using the same costume model from the previous film. Screenshot (cropped) from *Shrek 2*.

Figures 27–28 Fairy Godmother's two dresses have an identical shape; however, the appearance of two different costumes has been achieved with different colouring and texture finishing. Screenshots (cropped) from *Shrek 2*.

Figure 29 The costume model for the Fairy Godmother's dress in the final scene has been altered at the hemline. Screenshot (cropped) from *Shrek 2*.

Figure 30 This figure indicates that the character costume colours and textures on Fiona and the Queen reflect the melancholic mood in this scene. The advancements in computer animation software, such as DreamWorks "fabric shading model", enabled an accurate depiction of different material textures also in specific lighting, visible in this scene. Fiona's costume model in this scene is re-used from the previous film *Shrek 2*. Screenshot from *Shrek the Third*.

Figure 31 During the King's funeral, the Queen and Fiona's costume colours and textures are changed to dark grey tones with a less elaborate pattern on the dress fabric. Screenshot from *Shrek the Third*.

Figure 32 The parchment depicting the *Story of Alexander the Great*, circa 1450, illustrates women's fashions from the High Middle Ages in Northern Europe. Unknown artist, held at the Bibliothèque nationale de France, Paris. Image source: Bibliothèque nationale de France, Public domain, via Wikimedia Commons.

Figures 33–34 Isis Mussenden's costume drawing for the character Lord Farquaad shows that she originally designed him with a floor-length cape with plenty of volume. However, the character's cape was created much shorter and narrower in the animated film due to cloth and object-cloth collision issues. Figure 33 courtesy of Isis Mussenden; Figure 34 screenshot (cropped) from *Shrek*.

Figure 35 There were only a few period elements from the height of the Middle Ages included in Princess Fiona's costume because of the cloth collision effect in simulation and computer animation. Courtesy of Isis Mussenden.

Figure 36 The decorative pattern on Fiona's bodice and neckline was the only detail in her costume that specifically reflected the Middle Ages, circa 14th century. Screenshot (cropped) from *Shrek*.

Figure 37 The figure illustrates one of the Merry Men characters whose costumes aligned with period fashions from the height of the Middle Ages. Screenshot from *Shrek*.

Figure 38 Animator Kelly Kimball's costume designs for the character Shrek for the film *Shrek*. Early designs of Shrek reflect the original illustrations presented in the children's book by William Steig. Even though the character's form changed from these illustrations, the stained visual look in his costume remained the same in the film. Courtesy of Kelly Kimball.

Figure 39 Ruth Myers' costume drawing of the character Nebbercracker for the film *Monster House* shows how the costume designer wished the physical condition of the costume to be depicted in the animated film. Courtesy of Ruth Myers.

Figure 40 Nebbercracker chasing after D.J. The worn and stained appearance shown in Myers' costume drawing is also digitally reproduced in Nebbercracker's costume in the final animation. Screenshot (cropped) from *Monster House*.

Figures 41–42 Isis Mussenden's costume drawing for Prince Charming depicts gold colours that reflect his flashy personality. The appearance of shiny sateen material visually links with his personality and royal status. The original design in the drawing was slightly altered for the animation. Figure 41 courtesy of Isis Mussenden; Figure 42 screenshot (cropped) from *Shrek 2*.

Figure 43 Worn material textures in the film *Puss in Boots* enhanced the perceptive understanding of the costume, linking the costumes better with the characters' personal story development. Screenshot from *Puss in Boots*.

Figure 44 Worn leather finishing and stitching in the sole of the boots are examples of how costumes in *Puss in Boots* create a better tactile connection. Screenshot from *Puss in Boots*.

Figure 45 Hiro lies on the ground due to the force from the explosion. Screenshot (cropped) from *Big Hero 6*.

Figure 46 Close shot of Hiro shows that the explosion and physical action do not soil his clothing. Screenshot (cropped) from *Big Hero 6*.

Figure 47 Isis Mussenden's costume sketch for the little orphans who performed as generic characters in *Puss in Boots*. Courtesy of Isis Mussenden.

Figures 48–50 Examples of garment pieces on generic characters in *Puss in Boots*. These computer-generated models were created after Isis Mussenden designed a variety of different garments and costume ensembles. Courtesy of Isis Mussenden.

Figures 51–53 Isis Mussenden's costume designs for the generic characters in *Shrek 2*. The drawings demonstrate how the different garment pieces were combined to create a costume ensemble. The drawings indicate the different number codes for each garment. Courtesy of Isis Mussenden.

Figure 54 Generic characters in a crowd scene in *Shrek*. The costumes are built from the same costume models, multiplied on each character. The male tunics are created from two different costume models. Screenshot from *Shrek*.

Figure 55 The same male tunic model on the generic characters is used in the crowd scene at the end of the film *Shrek*. Screenshot from *Shrek*.

Figures 56–57 Isis Mussenden's generic character costume designs for *Puss in Boots* show that generic characters can enhance the visual connection with the location and time. Courtesy of Isis Mussenden.

Figures 58–59 These particular garments are time-consuming to create with computer animation and are therefore examples of the generic character costumes that have "low priority". Courtesy of Isis Mussenden.

Figure 60 A crowd scene shows the variety of body types and costumes for the generic characters in *Big Hero 6*. Screenshot from *Big Hero 6*.

Figures 61–64 Israel Segal's costume design suggestions for the character Guinevere, prior to the decision of devaluing her as one of the generic characters. Courtesy of Israel Segal.

Figure 65 The importance of the character Guinevere changed during the scriptwriting process, and she ended up wearing the same costume as all the generic characters in this scene. Screenshot from *Shrek the Third*.

Figures 66–67 Segal's costume design options for the character Artie in *Shrek the Third* were used as inspirations for the costumes on the high school boys. These were generic characters who acted in the same scene where Artie is first introduced to the spectators. Courtesy of Israel Segal.

Figure 68 The lead character Artie is introduced in the film as one of the generic characters. Therefore, his costume design matches with the generics, and he does not have a personal costume design style. Screenshot from *Shrek the Third*.

Figures 69–70 Examples of Isis Mussenden's visual exploration for digital character costume design in *Puss in Boots*. Mussenden used the

colours in these tiles and mosaics for the colour scheme in the film's costumes. Courtesy of Isis Mussenden.

Figures 71–72 These visual images provided ideas of period-specific garments and textures for digital character costume design in *Puss in Boots*. Figure 71 is a copy of "The Circumcision" by Marco Marziale, (undated), housed at the National Gallery, London. Figure 72 is a copy of a "Portrait of a Young Venetian Lady" by Albrecht Dürer, 1505, housed at the Kunsthistorisches Museum, Vienna. Copies courtesy of Isis Mussenden.

Figure 73 This example page includes a collage of visual references supporting the interpretation of ideas from the Renaissance paintings (in Figures 71 and 72) and provides a greater variety of textures and weaving design ideas for the character costumes in *Puss in Boots*. Courtesy of Isis Mussenden.

Figure 74 Mussenden's visual reference of cross-stitching, which appears to be part of a folk costume. The richness of texture in this particular image enables better translation of the design in the animated garment. Image courtesy of Isis Mussenden.

Figure 75 The stitch design is transferred to orphanage leader Imelda's blouse; however, the texture is flatter. Screenshot (cropped) from *Puss in Boots*.

Figures 76–78 Examples of tangible material references included in Israel Segal's costume drawings for characters Fiona, the Queen, and a generic character in *Shrek the Third*. Courtesy of Israel Segal.

Figure 79 The design and outer layer of a Comme des Garçons skirt were physical garment references employed in digital character costume design in *Big Hero 6*. Courtesy of Danny Flynn.

Figure 80 Danny Flynn shows the skirt material in more detail and the plastic air pockets placed inside the hemline of the skirt. These create a puffed, round look for the skirt hem. The same effect was implemented in the design of the overall look of character Baymax. Courtesy of Danny Flynn.

Figure 81 Character Baymax's visual appearance in *Big Hero 6*. Screenshot from *Big Hero 6*.

Figures 82–83 Two visual images of Pierre Cardin outfits (circa 1970s) were Danny Flynn's inspirational references for the character Go Go Tomago's superhero costume in Big Hero 6. Images are copies from Hesse (2010: 69, 100–101) Pierre Cardin: 60 Years of Innovation. Courtesy of Danny Flynn.

Figures 84–85 The images used in visual exploration at an early stage of the costume design development demonstrate that the disc detail was chosen in the final digital design of Go Go Tomago's costume and inspired her action in some of the film's scenes. Screenshots from Big Hero 6.

Figure 86 Costumes on the round body shape of Russell and square body of Carl required specific patterns. Screenshot from *Up*.

Figure 87 The front pattern piece for the character Handsome Shrek's tunic in *Shrek 2*. The pattern demonstrates that several details regarding the style and construction of the garment can be included in the physical pattern to assist the computer animation. Letter A by the side seam shows the place where the side seams are joined; letter B on the shoulder indicates the shoulder seams; letter C shows the place for the wing. Courtesy of Isis Mussenden.

Figures 88–89 The cape pattern supports the costume drawing, and these both assisted the digital execution of the attire on Puss in Boots in *Shrek 2*. Courtesy of Isis Mussenden.

Figure 90 Isis Mussenden made accurate drawings to indicate more specific information regarding the details on Puss in Boots' cape in *Shrek 2*. Courtesy of Isis Mussenden.

Figures 91–92 The final animation shows that the design for Puss' cape and its details differ from Isis Mussenden's original designs. The pendant, ribbon, and volume differ from Mussenden's original costume drawing. Screenshots from *Shrek 2*.

Figure 93 Photos of costume designer Ruth Myers' jacket and shoe references for the schoolgirl Jenny in *Monster House*. Courtesy of Ruth Myers.

Figure 94 This screenshot demonstrates that the physical references of the jacket and shoes are reproduced accurately in the digital costume. The colour and shine of the shoes resemble the original tangible example of shiny leather. Screenshot from *Monster House*.

Figure 95 Isis Mussenden's costume drawing depicts the costume ensemble for Handsome Shrek after he has transformed into a human form. The size and repetition of the print on the vest over the tunic are successfully reproduced in the digital version. Courtesy of Isis Mussenden.

Figure 96 A more detailed drawing of the tunic and tangible material samples of the trimmings assisted in the computer animation of the costume. Courtesy of Isis Mussenden.

Figure 97 Drawing of the print design illustrates the repetition, colours, and materials for the vest. Courtesy of Isis Mussenden.

Figure 98 Handsome Shrek's costume ensemble in the final animation shows how accurately Mussenden's costume design has been digitally recreated. Tangible references from the trimmings assisted the digital creation of depth in the pattern of the vest, which brings more three-dimensionality to the costume. However, the texture of the vest appears as a velvet material, which suggests that the sateen material was not included in the digital costume. Screenshot (cropped) from *Shrek 2*.

Front cover: Drawing courtesy of Israel Segal

Back cover and the flap: Screenshot from *Shrek the Third*

Chapter 1: Screenshot from *Shrek*

Chapter 2: Screenshot from *Shrek 2*

Chapter 3: Screenshot from *Shrek 2*

Chapter 4: Screenshot from *Big Hero 6*

Chapter 5: Screenshot from *Puss in Boots*

Chapter 6: Screenshot from *Monster House*

Maarit photo: Mia Surakka

INTRODUCTION

‘This is a hobo suit darling; you can’t be seen in this. I won’t allow it! Fifteen years ago, maybe, but now? Feh!’, cries fashion designer Edna Mode to Mr Incredible in the popular Pixar computer-animated film *The Incredibles* (Bird 2004). In the film’s narrative, and its sequel *Incredibles 2* (Bird 2018), the character Mode designs fashionable and practical “hero-wear”, i.e., superhero costumes, for the members of the Incredible family. Mode underscores several times throughout the films that it is important for the design of the costume to serve the characteristics of the superhero characters and their special movements and to appropriately match each character’s personality, physicality, and superpowers.

Even though the narrative of *The Incredibles* films includes a costume designer as a clearly delineated character, surprisingly, throughout the history of Hollywood animation, the design of costumes has been folded into the process of character animation rather than being a separate sphere of labour executed by a costume designer. The animators often act as auteurs of character and costume design, where the process and decisions behind costumes are integrated into the phase of character development and creation. As a result, the design development and contribution of costume design for animated character identities and its role in storytelling remain relatively

unknown. The different aspects in costumes, such as colours, materials, construction, and fit, are developed in parallel with the animator's character development, a phase in which animators try to 'encompass the feeling of the characters, their attitudes, their body shapes, their facial features, hairstyles, and their costume… all of that, at the same time' (Silver 2017). Most likely because the design of the costume is merged with the character creation stage of animated film production, it has been neither recognised as a clearly defined role/profession within the animation industry nor acknowledged as a significant and central part of the characters' visual representation, performance, and connection to the world of the film. As a consequence, the valuable input of a costume designer in collaborative animated filmmaking has not been the subject of extended academic focus. The aim of this doctoral thesis is to bring to the fore the topic of costume design in animation and to illuminate the invisible stages of costume design and the vital expert labour of a costume designer in computer-animated film productions. The thesis identifies the role of the costume designer through the small number of films that have employed and, importantly, credited a costume designer as part of the production. It therefore offers a closer examination of digital costume design in the context of computer-animated films through the work and expertise of these designers.

The contribution of a clearly defined costume designer in animated film productions in Hollywood was not seen until *Who Framed Roger Rabbit* (Zemeckis 1988), a film combining live-action and animation. Joanna Johnston was originally appointed to design the costumes for the live characters, but she also contributed to some of the animated character's costume designs. Before this, films such as Disney's *Mary Poppins* (Stevenson 1964), which also combined hand-drawn animation with live-action sequences of the (human) actors, did not recognise a costume designer in the film's end credits. Instead, a "wardrobe crew" was given credit as the designers of the costumes for the live-action scenes (Mary Poppins). In *Mary Poppins*, there is no acknowledgement of the animated characters' costumes either, presumably because these were designed by the Disney animators as part of their character development process. Of the numerous animated films produced in Hollywood, the work of costume designer and animator Kelly Kimball in DreamWorks' hand-drawn animated films *The Prince of Egypt* (Chapman, Hickner, and Wells 1998) and *Road to El Dorado* (Bergeron, Paul, and Katzenberg 2000) stands out as significant by being the first and at that time only fully animated films acknowledging a costume designer in the films' closing credits.[1] Credit is crucial because it not only shows the work and contribution of the designers, but also makes visible the costume design phase in films. For example, costume designer Kate Bergh assisted in the designs of character costumes in *Hercules* (Clements, Musker 1997) (Bergh 2019); however, her name remains absent from the film's end credits. Therefore, the role and contribution of a costume designer and the recognition of the important process of costume design as a phase within the creation of animation again remain unmentioned within the Hollywood animation industry. As Langer (1990) argues, Disney Animation Studios set the template for feature animation production processes in the 1930s, which was then borrowed by other animation studios. Disney formed both the industrial and aesthetic style where the character development process was intertwined with the process of costume design as well. Therefore, the perceived absence of costume designers in Disney film productions might explain the absence of a costume designer in animation in general, as indicated in the previous 'template' established by this important production company.

Where previous studies in costume design[2] have acknowledged the essential contribution of costume design and costume designer as part of the design, making, presentation, and representation of characters in film and live performance, by comparison scholarly studies from the field of animation have sidelined the vital role of costume as part of character creation, performance, and narrative. Numerous scholarly publications tend to discuss character development, performance, and world building but make only cursory reference to how costume design is part of these aspects of character design in animated film productions. As a costume designer has not historically been engaged as part of animated film productions, the different phases of costume design and decisions behind the important visual aspects of costumes are merged with other stages of production in animation filmmaking, and therefore are not regarded in scholarship nor by the industry

[1] In this research, I do not analyse *The Prince of Egypt* and *Road to El Dorado* because these are hand-drawn animations, as my thesis focuses on computer animation.

[2] For film costume design, see for example, Nadoolman Landis (2012a, 2012c, 2003); Stutesman (2019); Paulicelli, Stutesman and Wallenberg (2017); Street (2001); Gaines (1990). For theatre and live performance, see for example, Howard (2019); Barbieri (2017); Maclaurin and Monks (2014); Monks (2010). The wide array of roles that costume holds is discussed in Pantouvaki and McNeil (2021) and in contributions by various authors to the journal *Studies in Costume and Performance*, which is dedicated to costume.

with the necessary rigour. Consequently, the role of costume designer and importance of costume design in animation are largely undermined and remain a largely unknown and unacknowledged practice.

DreamWorks' *Shrek* (Vernon, Ashbury, and Adamson 2001) stands out as the first feature-length computer-animated film in Hollywood[3] employing and crediting the work of professional costume designer Isis Mussenden. According to her account (2016a), Mussenden was brought into this film production because producer Aron Warner saw the value of collaborating with a costume designer to share her knowledge on physical materials, patterns, and visualising of character identities through costume. Prior to 2016 when I started this doctoral study, only six computer-animated films gave credit to the work of a costume designer, among hundreds of computer-animated features produced in Hollywood. This means that in numerous computer-animated films, costumes were designed by another type of professional, e.g., an animator, character designer, or visual development artist.

To embrace the contribution of costume designers in the collaborative development of computer-animated films, I have framed this research to focus on those six computer animations that did engage a costume designer in the production. My research, therefore, focuses on costume designer Isis Mussenden and her work on DreamWorks' *Shrek, Shrek 2* (Vernon, Ashbury, and Adamson 2004), and *Puss in Boots* (Miller 2011); Israel Segal's costume design for *Shrek the Third* (Miller 2007); Ruth Myers' contribution for ImageMovers' *Monster House* (Kenan 2006); and Danny Flynn's costume designs for Disney Animations' *Big Hero 6* (Hall and Williams 2014). These films represent only a small portion of the animated films produced in Hollywood; however, they are important examples of involving professional costume designers, which, as stated, has previously been an uncommon feature in animated film productions. Examining the costume designers' work across these case study films enables the illumination of the stages and process of costume design in contemporary animated film productions. The work of these costume designers operates as a further catalyst for examining how the design of costume connects with animated character identification, films' narrative, and specific scenes. The collaborative costume design development for the digital characters and the costume designer's experiences working in these computer-animated films make up the core research material for this thesis.

Contemporary animation in western culture is mainly centred in Hollywood and produced by animation studios such as Disney, Pixar, DreamWorks, and Sony, each of which annually creates popular computer animations. For example, Pixar's *Toy Story* franchise, Pixar/Disney computer-animated film series *Cars*, and Disney's recent *Frozen* phenomenon illustrate the international popularity of these films. A part of my study, DreamWorks' *Shrek* franchise also represents a large budgeted and popular Hollywood production. These franchises are interesting from a costume design perspective as the character costumes are later re-designed as commercial merchandise products or stage costumes for musical performances.

The investments and growth of Hollywood animation studios have been evident since the release of the first feature-length computer-animated film *Toy Story* (Lasseter 1995) and visible in the development of software, the number of technical innovations, and a variety of workforce skills and expertise within the different production companies (Holliday 2018: 2).[4] In addition to choosing my case study films based on the criterion that a costume designer has been employed as part of the production, I have centred my research around Hollywood animation because of the technical resources and innovations these large production companies put into the development of their films, which consequently have an impact on the credibility of character costume design. The popularity of Hollywood animation is also visible in the number of scholarly publications that exist, enabling me to use previous research, which includes viewpoints beyond costume. Further, the publications support this research from the perspective of costume. As I later show in my literature review, these previous discussions explore factors of character development such as drawing and representation, as well as acting and performance, while at the same time sidelining the significant meaning of costume design as part of these areas. I strongly believe that costume design and equally the work of a costume designer deserve to be recognised in the context of computer animation and character creation where they contribute to the wider frame of animation and costume studies.

[3] The first computer-animated feature film produced in Hollywood that included human characters was *Final Fantasy: The Spirits Within* (Sakaguchi 2001); however, it did not acknowledge a costume designer in the film's closing credits.

[4] For more information on Hollywood computer-animation medium, see Holliday (2018) *The Computer-Animated Film. Industry, Style and Genre*; Sito (2013) *Moving Innovation. A History of Computer Animation*; and Brown's (2021) recent publication *Contemporary Hollywood Animation: Style, Storytelling, Culture and Ideology Since the 1990s.*

As a result, the films that engage costume designers allow us to examine the role of costume within animated films in general.

The interest for this study rests in my background as an actively working costume designer and my personal experience of developing the visual appearance for different kinds of (live performing) characters. Throughout my career of over fifteen years, I have been aware of the integration of digital technology into the costume designer's profession, which has led to new ways and possibilities to design. For example, in my own design work, instead of drawing and painting traditionally on paper, I instead use digital drawing methods such as applications on an Apple iPad. On stage, I have included projections and wearable electronics in costumes for visual impact and storytelling purposes. Computer-animated films intensify this form of digital labour, which piques my interest because all aspects of character costumes are constructed with computer software, allowing the creation of new kinds of costumes and materials that are simply not possible with garments constructed from traditional tailoring methods and physical materials. Paul Wells (1998) argues that the animation medium enables artists to defy the laws of the real world and stretch the representation of the real to new aesthetic dimensions. This statement corresponds with my personal interests, and I have chosen to further investigate how the imaginative and creative possibilities of animation expand into the animated character's costume design, specifically in computer-animated films where these digital worlds are built using new computer technologies. The computer animation medium and digitally animated costumes provide a perfect platform to study the effects of digital technology on costume design, which is my personal area of interest.

Framing the work: aims and research questions

By specifically focusing on those six computer-animated films that have included a professional costume designer in the productions, my research aims are two-fold. First, with an industry approach, I aim to examine the costume designers' role and phases of costume design development as part of pre-established workflow in computer-animated film productions, since there has existed such a long tradition of animators being responsible for the character costume design. Second, by employing a comparative analysis with an emphasis on the visual aspects, I investigate the visual characteristics and sensorial dimensions that digitally animated costumes convey regarding the representation of characters' personalities and connection to narrative. My aim is to explore the forms of multidisciplinary collaboration and the different elements that are part of the costume design process for animated characters, by emphasising the costume designers' experiences. I focus on the phases in animated film production that include costume designers and also investigate character design development and how aspects such as a character's bodily form, personality, and performance are developed and how costume design supports these aspects.

In the visual approach, my goal is to explore how digital character costumes express characters' personality and personal history through visual means that have an impact on many sensorial levels for both creators and audiences. In addition, I aim to investigate costume's visual connection to the narrative and changes in storyline, as well as costume's role in characters' performative action. These aims include the impact of technology on the design and creation of digital character costume with computer-animation software and how this process involves the work of a costume designer. The thesis does not discuss the reception of costume design in animated films, focusing instead on the process of designing and making digitally animated costumes, as my interest as well as my expertise focus on production and not reception.

As part of this research, I study the impact of working with digital entities since there exists a strong contrast between computer animation and traditional costume design methods. In live-action films and live performance, costume designers interact and collaborate with physical actors to design costumes that serve their vision of the character, whereas in computer animations, costumes for digital characters are designed without an actor's presence. Another intriguing point in computer animation is the creation of character costumes constructed with certain animation software rather than tangible, real-world materials, although tangible materials are employed as references in this work. Methods of creating costumes digitally with such software are still relatively unknown, as are the effects of technological development on how costumes are designed and constructed with animation programs. Therefore, my aim is also to explore the technological aspect of digital character costume design and how technology is visible in costume design development as well as in the representation of the final digitally animated costume. Moreover, by noting that tangible materials are

highly present in the making of physical costumes, this thesis investigates the relation between tangible and digital materials and aims to show how tangible materials remain part of digital costume design even within the production of computer-animated films. Studying materiality as part of costume design enables me to illustrate the connection between the real world and the digital world.

In order to investigate these aims, I have formulated the main research question as follows:

> What are the key characteristics of costume design for digital characters in computer-animated films?

This question focuses on the parts of the costume designer's work process that mainly involve costume design development for digital characters, specifically in computer-animated films. I explore the costume designer's collaborative work process in this context and seek to understand the different aspects involved in digital character costume design development and the creation of the final animated costume.

As the scope of the main research question covers broadly the theme of costume design for digital characters and the work of the designer, I have formulated two sub-questions for the purpose of investigating two specific aspects, digitality and materiality, which are involved in digital character costume design within the computer-animated film context. The first sub-question asks:

> 1. How does technology development in computer animation affect the costume design process and the final outcome of the character's digital costume?

The first sub-question focuses on the relationship between costume design and the development of computer animation, especially the software programs used for digital character costume creation. The aim is to discuss, from the costume designer's perspective, the relationship between animation software and costume design, and the effects of technology on costume design development.

In order to explore the differences between the physical materiality of traditional costume design for live actors and the digital materiality for computer-animated characters, I have framed the second sub-question as:

> 2. In what ways are tangible materials part of digital character costume design?

The second sub-question seeks answers that define/reveal the role of tangible materials in digital character costume design development and in the digital creation of the costume. In my thesis, the term "tangible materials" relates to real-world visual references and all kinds of tangible, physical materials that are used as a reference for digital character costume design. I explore how tangible materials are used in the costume design process. I also focus on texture and examine how tangible materials are implemented in the creation of the digital costume texture in computer-animated films.

This research focus is rooted in my background of being an actively working costume designer. As Roni Berger (2015) remarks, the researcher's background affects the research process, for example, in the vocabulary used in the study and the ways that research questions are formulated.[5] In this research, my professional background influences the ways I framed this work, the topics included, the kind of research questions I prepared, and how I navigate the research process. Berger's (2015: 220) phrasing, 'the lens for filtering the information' during the course of research, seems especially suitable to my work, where I investigate, interpret, and analyse the materials and formulate conclusions through the "costume designer's lens". Hence, I acknowledge that this approach 'may shape the findings and conclusions of the study' (Berger 2015: 220).

My cross-disciplinary research is positioned between costume design studies and film studies, with a focus on animation (Figure 1). There is a potential gap for a researcher position in the intersection of the fields of animation and costume design, which my research aims to fill. Focusing on the six computer-animated films that have employed a costume designer provides a focal point that enables an understanding and thus the creation of new

[5] Researcher's position is also discussed by Lea Kacen &Julia Chaitin (2006).

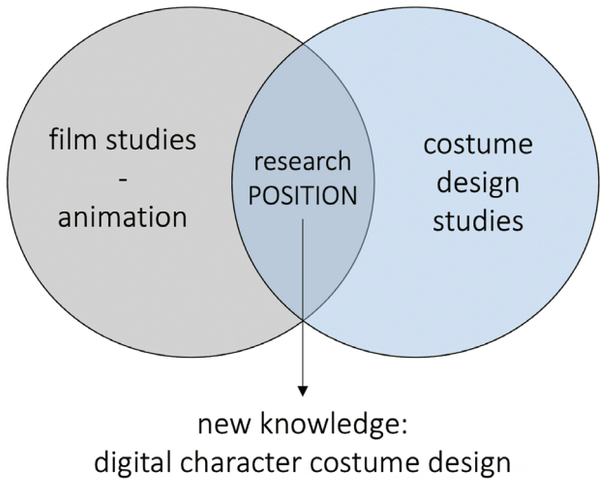


Figure 1. My cross-disciplinary research is located within the cross-section of costume design and animation. This approach brings new knowledge on digital characters' costume design.

knowledge specifically of costume design in computer-animated feature films.

Animation is 'the most dynamic form of expression available to creative people' according to animation scholar Paul Wells (2006: 6); different forms of expressions are discernible in the various animation mediums that exist. In addition to the medium of computer animation where animated worlds are fabricated with computer software, animated films can also be created via drawn images for hand-drawn animation, cut-out forms, and materials and techniques for making stop-motion animation (e.g., puppets and clay). Each of these are equally creative mediums and also deserve recognition in research on costume design. However, I have excluded these mediums from my study, as I wished to frame the research on costume designers' expert professional creative input in animation within computer-animated films. I wanted to illuminate the costume designer's contribution to animated films by using six films that have expressly engaged a costume designer in the production. Doing so offers a viewpoint to delve into this specific design process and explore the impact of costume design on animated character representation. I also sought to focus on the technological aspect of animation and how it impacts the design and creation of digital costumes; therefore, focusing solely on computer-animated films was a logical choice.

Thesis structure

This thesis is divided into six chapters. First, the current section, **Introduction**, presents the motivation for this research, its aims, and research questions. The first chapter, **Setting up the scene: costume design in animation**, provides a foundation for this research through selected literature from studies on costume design and animation and discusses those various aspects that involve costume design in animation. The second chapter on **Research design** presents the methodological and theoretical decisions I have made to execute this study. This research is data-driven; therefore, the theoretical framing is formulated from the research data analysis and presented after the methodological approach. Chapters 3, 4, and 5 stand as the main corpus of this study and present findings and analysis of the research data. The chapter sections employ a cross-examination of various case study films; of these, some sections focus more specifically on a certain film and credited designer on that film to support the analysis of specific aspects.

Chapter 3, **Costume designers as part of collaborative computer-animated film productions**, focuses on the introduction of a costume designer in the collaborative animated filmmaking practice. It sheds light on the different ways that professional costume designers collaborate within computer-animated films. Various departments within film productions, such as story and character development, operate in parallel to each other. As analysed in this chapter, costume design is affected by storyline changes and character development, thus offering a place for the costume designer to integrate in the film's development across different departments. This chapter has an industry focus and concentrates on the workflows of animated film productions, where the costume designer is a fairly new, but essential professional collaborator.

The fourth chapter, **Digitally animated costumes**, investigates the ways that technological issues influence digital characters' costume design. Each year, computer-animation software develops and operates as one of the assets in the fierce competition between animated film production companies. Digital costumes are highly technological and created with animation software whose capacity dictates the success of the digital costumes. This chapter explores the different ways the development of technology shapes costume design and how digitally animated costumes are constructed. I connect my data analysis in this chapter with technological industry

papers by discussing how animation software programs are developed and employed in the creation of computer-animated costumes, bringing new information on how technology is connected to costume design.

Chapter 5, **From tangible materials to digital costumes**, expands the discussion to the various ways tangible materials operate in the design development and depiction of digital characters' costumes. Of the three chapters that analyse the research materials, this one engages the most with the chosen theories. I intertwine the data analysis with the theoretical concepts of *somaesthetics*, *sensory perception,* and *haptic perception*, discussed by scholars Richard Shusterman (1999, 2012) and Laura U. Marks (2000, 2002). My analysis reveals that exploring tangible materials during costume design development guides the design process and that costume designers make decisions for costume designs based on somatic and aesthetic choices. The data show that physical, real-world materiality is an important marker of credibility in computer-animated film productions.

In Chapter 6, **Research conclusions**, I return to the research questions and discuss the results of my research through four central ideas that emerged from my study findings. I also consider limitations of my study. The thesis concludes with ideas for future research and the implications of these findings on academic and industry practice in relation to costume design's effect on animation performance and script development as well as the costume designer's involvement in creating digital costumes.

CHAPTER 1

CHAPTER 1

SETTING UP THE SCENE: COSTUME DESIGN IN ANIMATION

This chapter explores the ways in which costume design is part of character development and design in the context of animation through selected theoretical, historical, and industry literature. Throughout animation scholarship, publications rarely reference costume design as a discrete element, presumably because costume design has a tradition within animation production of being merged into or subsumed by multiple areas of animated character development. In those publications that do mention costume, the remarks are often cursory or tangential. Therefore, to reference notable costume design–related areas missing from animation literature, I also reflect on studies in costume design, making this chapter a scholarly review of selected literature drawn from multiple fields.

Rather than discussing publications by individual authors across studies in costume and animation, I present the literature that connects to my research by organising it under themes that relate to different parts of costume design in animation. First, I have chosen to describe concepts on the topic of character representation through debates on how costumes visually portray characters' identity. This remains one of the most crucial areas of costume design, alongside costume design's vital role in the dramaturgical support of a film's narrative. Thereafter, I present literature on the topic of

acting and performance in animation, indicating the criticality of costume for an actor, but also for an animator to embody the character and facilitate their performance. Later, I review literature on how animation performance connects to representational drawing and real-life observation. This is a part of costume design in which real-life garments and materials are observed to draw physical material qualities accurately on an animated character and in movement. I conclude the literature review with studies that centre on the theme of this thesis, the connections between computer animation and costume design. I present literature on how the computer animation medium influences the representation of characters, environments, and textures that together build the visual outcome of an animated film. Some of the literature focuses specifically on Disney films, which are dominant examples in discussions in animation scholarship when examining costume design–related areas. I have excluded some central literature in costume design studies[6] from this review because it does not engage strongly with the areas related to my thesis topic. The literature review in this chapter formed the foundation for my further research by illustrating some of the areas involved in digital character costume design in computer-animated films and by indicating where existing literature would need to be consulted together with other sources, such as oral records.

Costume design and character representation

'Before an actor speaks, his wardrobe has already spoken for him'
(Nadoolman Landis 2003: 9)

Clothing is deeply connected with our identity, expressing something about our gender, class, or status in the world we live, argued fashion scholar Joanne Entwistle (2000: 112). Similar visual connections of social and geographical aspects of our everyday clothing are employed in film and live performance costumes. Hence, costumes are powerful in visually portraying the personality and fictional histories of a character through carefully chosen details that include specific materials, colours, garment structures, and fit. Costume design assists characters to come "alive", allowing them to feel true to the spectators and to connect them in the evolving narratives. Due to its centrality in costume design, the topic is explored by scholars from all areas of costume practice, including within both film and theatre. Distinguished costume designer and scholar Deborah Nadoolman Landis (2012a: 48) sets up this area of focus by stating that costumes are like our everyday clothing, as 'we all wear an amalgam of stories, each item telling its own unique tale.' Likewise, character costumes 'can also reveal and conceal our moods, taste and personality, our social and economic aspirations and the time in which we live' (ibid.). Nadoolman Landis' many publications contribute to the central role of costume in the visual representation of characters in live-action films. She also highlights the work of a costume designer as part of the creative filmmaking team, for example, in her publications *Hollywood Costume* (2012a), *FilmCraft: Costume Design* (2012c), and *Screencraft: Costume Design* (2003). These publications have been supportive sources for my research in different areas of costume design and are cited across this literature review and the thesis.

One important aspect of character representation is the indistinguishable connection between a costume and character. Theatre scholar Aoife Monks (2010) explains this further in her publication *The Actor in Costume* where she argues that the actor and costume are indistinguishable in both perceptual and embodied levels. Regarding the perceptual indistinguishability of the actor and costume, which relates to visual representation of the character, Monks (2010: 11) argues that 'when a costumed actor appears on stage, it is often very difficult to tell where the costume leaves off and the actor begins.' The actor and costume together create the character, and there is no distinction between the two. Monks (2010: 20, 33) continues that 'when spectators look at an actor … in costume on stage, whom and what do they see? The borders between the actor and costume are unclear' and that 'in the end, there is no difference between actors and their costumes.' The costume has a strong connection with the character by reflecting its personality visually and in fact illustrating the character for the spectator. Although Monks discusses real actors and physical acting on stage, the approach of an indistinguishable union between the character and costume has given theoretical grounding for my research in costume design in animation. In my work, I expand this concept to explore the ways in which digital technology

[6] In addition to sources included in this literature review, costume has been examined in the context of live performance also by Barbieri (2017). In the frame of film studies and specifically from the viewpoint of fashion/dress studies in relation to film, other important literature derives from Stutesman (2021, 2019, 2018); Paulicelli, Stutesman, and Wallenberg (2017).

allows for rethinking of indistinguishability, specifically the indistinguishable connection of digitally animated characters and their costumes.

In studies relating to animation, costumes as part of character representation are briefly mentioned in an early critical exploration by animation scholar Paul Wells (1998) and animation historian Robin Allan (1999) and in more recent publications by Charles Solomon (2014, 2015). Wells (1998) briefly touches on aspects of character costume portrayal and costume in his publication *Understanding Animation*. One discussion connects to a larger theme concerning gender representation in animated cartoons such as Mickey and Minnie, as well as Tom and Jerry. In the costume design–related remarks concerning Mickey and Minnie Mouse, Wells (1998: 204) argues that the form of these two characters is drawn the same way; however, their decisive costumes differentiate them from each other. Wells notes that the 'female [character] is predominantly defined as a set of signifiers of femininity, i.e., skirts, panties, high-heeled shoes, etc., which also function as additional signifiers of character differentiation from the male model.' Minnie's femininity is represented through high-heel shoes, a hat decorated with a flower, and lace underwear shown underneath her skirt. Mickey, on the other hand, wears shorts and flat shoes. These decisive accessories become the identifiers of each character, making them easily recognisable. Wells' remarks connect the design of costume as part of character gender representation; however, the designs show how (fairly stereotypical) choices have been made to achieve the representation of either male or female genders. Wells' overall discussion regarding the male and female character representation (and character's body) in animation does provoke ideas for investigation of gender from a costume design perspective; however, the topic of gender is not part of my thesis' focus because the interview data directed the study to other topics, such as collaborative practices, the significance on technology, and perspectives relating to tangible and digital materiality.

Disney's animated feature films seem to be a common focal point for discussions on animated character costumes in studies by Allan and Solomon. Both scholars refer to different ideas relating to the ways that animators developed characters' visual representation, and intriguingly, the term costume was briefly mentioned in their discussions. In his book *Walt Disney and Europe* (1999) on the European influence in Disney's early hand-drawn animations, Allan argues how costumes were designed together with character development in pre-production of different Disney films. Allan's analysis suggests that ideas for character representation are drawn from concept art and story development discussions between the Disney animators. For example, the European storybook illustrations provided ideas for concept art, which operated as visual inspiration for character representation in Disney's early hand-drawn animations *Snow White and the Seven Dwarfs* (Hand et al. 1937), *Cinderella* (Geronimi, Jackson, and Luske 1950), and *Sleeping Beauty* (Geronimi 1959). Allan (1999: 38-39) explains how the animators took inspiration from European artist Ludvig Richter's illustrations for Snow White's early character development. He (1999:40) also remarks that Richter's illustrations were inspirational for the visual representation of the character Prince where '[t]he conventional romantic hero's costume, with jerkin, short sword and feathered cap, can also be seen in the Disney version.' However, in addition to this short description of his costume, the relationship between the visual representation of costume and the character remains unmentioned in Allan's study. The images of Richter's illustrations are included in Allan's book; however, they are not discussed further in the text. Therefore, the costume design–related aspects remain as brief suggestions, rather than as a part of a larger discussion of the development of characters' visual representation. Similarly, in other discussions regarding connections between character representation and costume, costume design–related aspects are scattered and therefore hard to find from Allan's narrative. However, Allan's remarks regarding the relation between concept art and costume design provide an area of focus in my thesis.

What I also found interesting in Allan's analysis was one of his sources, the animator's "Story Conference Notes", typed up during the production of *Snow White and the Seven Dwarfs*.[7] Story Conference Notes from the making of other Disney films have also been used by animation historian Charles Solomon in his publications *A Wish Your Heart Makes* (2015) and *Once Upon a Dream* (2014). *A Wish Your Heart Makes* provides insights into the production process of *Cinderella,* and *Once Upon a Dream* concentrates on similar issues in the making of Disney's *Sleeping Beauty*.[8] The Story Conference Notes give

[7] The animator's conversations typed in "Story Conference Notes" are held in the Disney Archives, Burbank, CA. The Story Conference Notes relating to the pre-production of *Snow White and the Seven Dwarfs* were copied by David R. Williams, in August 1987. Allan used Williams' copies in his analysis, which are currently held in the Collections of the British Film Institute Library, London.

[8] Solomon has been useful to cite in my two publications regarding costume design in Disney's early hand-drawn animations (see Kalmakurki 2018; 2021).

important background information on how character development occurs in animated film productions and the role of costume in these creative and collaborative conversations. It shows some of the ways that costume design is industrially understood, by merging this specific design process within character development and work of the animators. The story meeting notes have been a useful resource for my analysis in my publication on costume design in *Snow White and the Seven Dwarfs* (see Kalmakurki 2021). However, while this thesis does not focus on Disney but a range of animated film companies, the notes have facilitated an approach within my thesis to take note of costume design–related remarks in the collaborative discussions during the phase when a character's visual appearance is developed.

Neither of the aforementioned publications by Solomon, however, specifically refers to costume design per se. For example, regarding character portrayal in *Cinderella*, Solomon (2015: 61-63) interestingly points out that the representation of the Stepsisters, the King, and the Grand Duke had to be comic characters, whereas Cinderella, Prince, and Stepmother should each represent a "believable" character. The discussion around this topic includes interview material from Disney artists who were responsible for designing these characters and their costumes; however, the analysis does not include any information regarding how the costumes were designed to support the portrayal of these different character personalities. Allan's and Solomon's publications are useful supportive material for my thesis as they have broadened my understanding of how character design is developed in animation in general. They have also strengthened the idea that character costume design is treated in a perfunctory manner within animation scholarship, which concentrates on elements in character development other than costume design.

Character representation is connected to a broader context of characters' various cultural identities. Film scholar Noel Brown (2021) discusses various aspects related to identity in his recent publication *Contemporary Hollywood Animation*, specifically in his chapter 'Ways of Being: Identity and Hollywood Animation.' He brings to the fore the stereotypical character representation and the absence of gender, race, and diversity variation in animated films. Brown (2021) notes the recent shift in post-1990s Hollywood animation where, for example, Disney has increased the number of female lead roles and characters have represented various cultural and ethnic backgrounds, including indigenous people. As he remarks, Disney has collaborated with the Northern Scandinavian Sámi people in the making of *Frozen 2* and several specialists of the Polynesian islands culture in the making of *Moana*. Brown's chapter on identity, including topics such as cultural identity and gender representation, is relevant to costume design. For this reason, his publication is useful for considering identity more broadly. The book was published at the very final stages of writing this thesis; therefore, it will be more beneficial for my future research publications.

The many non-scholarly "*The Art of*" and "*The Making of*"[9] publications offer some general insights into character costume design to some extent; however, these are published by film production companies for marketing and publicity purposes. Specifically, Disney has been actively publishing "*The Art of*" books after their computer-animated film releases. Such literature is somewhat useful for this research study in providing comparative views on certain aspects of costume design in other film productions; however, these books do not offer critical nor theorised views of costume design in animation. One example is Jessica Julius' (2019) *The Art of Frozen 2*, where she provides a brief discussion on digital character representation in this particular Disney film. She describes the conversation relating to some of the decisions behind the costume design for the two lead characters Anna and Elsa. According to Julius' analysis, the lead characters' maturity and personality, for example, are conveyed by certain colours and details in their costumes. In the case of Anna, she at first wears an ivory dress that connotes youth and later on the colours change to dark tones that reflect her older age and stronger personality. Elsa's colour palette consists of the spectrum of jewel tones, which convey her personality previously established in the first film (Julius 2019: 31, 33). Such remarks suggest that the character development in the film did pay attention to colour and material texture in costumes as part of character representation, specifically as the character evolves in the film's progression, which belongs to what "costume design" comprises. Missing from Julius' writing is the discussion of similar issues for the other characters and connection to a larger context of costume design, as well as any theorising against relevant literature. In addition, a notable aspect is that Disney production teams do not identify this process as costume design, but as "visual development". The same issue is evident in the other "*The*

[9] For example, Disney productions *The Art of Brave* (Lerew 2012); *The Art of Frozen* (Solomon 2013); *The Art of Moana* (Julius and Malone 2016); and DreamWorks productions *The Art of How to Train Your Dragon* (Miller-Zameke and Cowell 2010); and *The Art of DreamWorks Kung Fu Panda 3* (Miller-Zameke 2016).

Art of" books, which discuss the design of costumes as primarily an integral part of character animation. The approach adopted in these publications demonstrates that costume design is not generally acknowledged as a defined sphere of labour separate from character design within the animation industry.

Evidently such cursory discussions about the relation between costume and character representation do not offer expert or critical views regarding the process and decisions of how costume design reflects the characters' personality in animation. On the other hand, the few remarks that can be found in animation literature provide insights on how costume design is developed in collaborative discussions between animators as they develop characters' personality and visual representation. In this thesis, I discuss character representation through costume specifically in Chapter 4. In addition to visual representation of characters' personality, costumes also provide visual support for the overall narrative context, as well as specific action in scenes.

Costumes as visual connectors of narrative

In live-action films and theatre performances, the most visible way to link characters with changes in evolving narrative is to provide visual information of time and place in costumes. In the field of costume design, scholarly writings acknowledge this important connection of the design of costumes with the narrative context. On this point, Nadoolman Landis (2003: 9) argues that 'costumes are designed to appear on one character, for one specific scene, in the emotional arch of a movie' by visually adding 'essential information to the moment of a scene, of a story, to help achieve the visual and narrative goal of the filmmaker.' Nadoolman Landis' remarks crystalise the purpose of costume for the narrative concept. Costumes are distinctive and powerful as visual connectors of narrative because they are easily embedded within geographical location and time period, as clothing evokes a particular time and place. The centrality of costume's visual connection with narrative is explained by Monks (2010) in the frame of theatre performance. She argues that character costumes are the main visual signifiers of a historical period and '[t]he use of historical costuming is frequently one of the main expressions of a director's interpretation of a play text, becoming significant of the context of the narrative' (Monks 2010: 21). Monks elaborates on this theme from the point of view of "aesthetic body", according to which costume conveys ideas that can be associated as a signal of historical or narrative ideas. Monks' notions on the topic of historical costumes provide support for my analysis when I discuss visual information regarding specific time periods in digitally animated costumes.

In addition to being vital in conveying period-related clues, specific costumes are powerful support for changes in action in scenes. Film scholar Jane Gaines (1990) discusses this in her publication *Fabrications: Costume and the Female Body*. Gaines (1990: 181) argues that [c]lothes… primarily work to reinforce narrative ideas,' and she gives a particular example where '[o]n occasion, an accessory planted as a prop may come to narrative fruition. A telltale glove or shoe… may start as part of an ensemble and later serve to advance the narrative.' Such detailed additions to the visual storytelling enhance the richness of a film or performance and facilitate spectators' emotions, where character costume change is an act that strengthens the particular dramatic change in the narrative. Nadoolman Landis (2012a: 52) continues on this topic by stating that costumes 'embed the psychological, social and emotional conditions of the character at a particular moment in the script.' These concepts by Monks, Gaines, and Nadoolman Landis regarding costumes depicting narrative ideas such as time period and action in the scenes are also a natural part of a costume designer's work. There is a clear concept, the ways costume works on a narrative level, that can be also investigated in the frame of animation.

In animation scholarship, the few references regarding depiction of time or historical period in a film's visual storytelling derive again from Allan (1999), Solomon (2014), and also from animation historian John Canemaker's (1996) publication *Before the Animation Begins.* Each of these scholars touches on the topic of historical referencing in character representation through one example, the work of concept artist Eyvind Earle in Disney's *Sleeping Beauty*. Earle painted the film's backgrounds to resemble medieval tapestries, which were inspired by medieval and Gothic paintings, tapestries, and architecture.[10] Especially Duc de Berry's illuminated manuscript *Très Riches Heures*, the *Book of Hours* (c. 1412–1416) functioned as the principal inspiration to Earle's designs (see Allan, 1999: 233; Solomon, 2014: 30; Canemaker 1996: 160). However, neither Allan nor Solomon nor Canemaker specifically discuss-

[10] This is also documented in the behind the scenes bonus material in the 2003 DVD release of *Sleeping Beauty*.

es the connection of these historical ideas in character costumes, such as how the historical costumes supported the narrative.[11] In addition to the example from *Sleeping Beauty*, Solomon (2013) illustrates another case where costumes linked with a time period in Disney's *Frozen* (Lee and Buck 2013). Solomon (2013: 34, 65) remarks that early in the production, the art direction first defined the film's time period to the 1600s. Later in pre-production, once the film was further developed, the focus shifted to another period to reflect the newly developed aesthetic design. The aesthetic design thereafter took inspirations from Norwegian landscape and history, while the costumes reflected the period of the 1840s, as 'the fashions of this time period had a more streamlined and crisper aesthetic than previous eras' (Solomon 2013: 65). These brief mentions show that in animation, period fashions in costumes are important connectors for time and contribute to the film's coherent visual style. However, these have not been specifically highlighted in animation scholarship and therefore require more thorough investigation to increase awareness in the field of this important topic.

Animation studies lack an in-depth analysis of this important aspect of period costume design and the ways that costumes are considered visual storytellers as part of narrative progression. In his interview, animator and professor Tom Sito (2017) emphasised the important connection between a film's time period and location on animated characters' costume designs. Sito worked on the design of the character Beast during the production of Disney's *Beauty and the Beast* (Trousdale and Wise 1991). The film takes place specifically in the provinces of France during the early 18th century. Sito explains that the location and time period were essential for the character costume design as the film was set specifically to 1706 or 1708 in the later years of Louis XIV, but it was not as elaborate as Versailles since it was in the provinces (Sito 2017). In order to visually engage the specific time and place in the character, he employed images from period-specific dress history books to find correct references for the animated characters' costumes. I wanted to include this information from Sito's interview for the purposes of this study to demonstrate how period and location are considered as part of character development and narrative visualisation in animation, but these

[11] Inspired by the historical references of the *Book of Hours* in *Sleeping Beauty*, I have analysed the film's costume design from this perspective. I remarked, for example, that the cut, colouring, and silhouette of the clothing on the people depicted in the miniature paintings of *April*, *May*, and *August* in the *Book of Hours* are all illustrated in Earle's concept art and thereafter depicted in the film's costumes, especially visible in the crowd scenes (see Kalmakurki 2018: 15).

remarks still remain as animators' tacit knowledge and are currently lacking in the literature. Further analyses and publications are needed to present more of the significance of costumes' relation to the narrative, also in the context of costumes' visual support for action in scenes. I will discuss this topic in Chapters 3, 4, and 5 because period-specific design links with various parts of animated film production.

Costume and performance

In live-action films and live performance, the actor is the protagonist in creating the character and performance. In the context of animation, the animator is the central person who creates the character performance, defined by Wells (1998: 110) with the term "animator/actor". The differences and similarities between acting in live performance and animation are described more recently by film scholar Stephen Prince (2012: 103) who remarks that the 'animator is an actor and works with the objectivity that an actor in live theatre does not have.' Thus, the animator is understood as the protagonist for giving the animated character their performance, expressions, feelings, and attitudes. The work of the actor, or animator, and the performance these professionals create are essential parts of costume design, as well as for my thesis where I argue that costumes assist the embodied experience of the animator and respond to characters' movements.

The significance of costume for the work of the actor and their performance creation is explored in the scholarship of costume. For example, from the viewpoint of collaboration between a costume designer and actor, the costume designer helps the actor find the psychological and physical nature of the character through costume. Gaines (1990) contributes to a larger context of costume representation in films specifically through the lens of feminist film theory. She remarks that actors 'stepping into a costume' is 'like stepping into a role' (1990: 184), in which the costume aids the actor's performance, as well as draws the distinction between the actor's personal and imaginative worlds. On this subject, arts practitioner and theatre scholar Melissa Trimingham's (2017: 138) central argument in her chapter titled 'Agency and empathy: Artists touch the body' is that costumes are richly empathic tools, which communicate somatically by transforming the body, and at the same time, affecting the mind of the wearer. Wearing a particular costume produces different emotions for the actor. Costume material

choices, construction, and fit all directly impact also the actor's mind and performance. Such aspects are at the forefront of costume design as they influence the success of the actor's performance. On this point, Monks (2010: 20) also argues that dressing up in costume is a point when the actor transforms into the character they are acting, in which the costume helps the 'actor to access the world of performance.' Gaines, Trimingham, and Monks equally argue that costume is central in transforming the actor's body and mind for the performance, and this operates as supporting material to my thesis to highlight the critical role of costume for the actor's profession.

In the context of animation, the animator carries out similar ways of embodying the character. Common strands in animation scholarship that identify the concept of embodiment are focused on the areas of animation acting and performance, as well as the medium's turn towards motion capture, as part of how digital technologies are used in animation. However, none examine the important contribution of costume to the acting and performance. Animation scholar Annabelle Honess Roe (2019) discusses the topic of animator as actor in her chapter 'Animation and Performance.' She argues that performance is a vital part of animation, involving similar skills of embodiment as in acting in order to bring a character to life and being on the screen. Honess Roe (2019: 69) remarks that '[a]nimated characters, unlike a human actor have no physical autonomy. They rely on the animator to move and, therefore, to come alive.' Animators evidently work in a similar fashion to actors and have a fundamental role in the animated character's believability. Similar notes regarding animator as actor are acknowledged by animation scholar Donald Crafton (2013) in his book *Shadow of a Mouse*, which contributes in detail to the topic of animation acting and performance creation. Crafton (2013: 45) remarks that animators transfer their own physical, psychological, and emotional senses into the character's design, movement, and personality. He states that 'the animators *are* the characters' while having the main role as the performer. In this performance, animators 'are participating as embodied characters within the narrative' (Crafton 2013: 45).[12] Crafton strongly suggests that the animators' embodied experience is important in bringing the character to life. The same is also acknowledged by Honess Roe (2019: 73) by arguing that 'embodied knowledge' is significant for understanding and interrogating a performance, where 'embodiment is inherent to the process of performance.'[13] From the viewpoint of costume design, if the animator has the role of the actor in embodying the character in order to create the performance, as studies in the field of costume (Monks 2010, Gaines 1990, Trimingham 2017) suggest, the design of costume must be taken into consideration while the animators create the character performance. The design of costume is central to the discussion when animators develop ideas and create the animated character's performance.

The lack of engagement in the literature on the topic of costume and animated performance reveals the undermined role of costume in this essential part of animated character development. Scholars such as Wells, Honess Roe, Prince, and Crafton equally discuss performance and acting in animation, but neither discusses the meaningfulness of costume in this process. Crafton (2013: 45) does state that 'animators clothe their characters'; however, by using the verb *clothe* he refers to character's psychology, personality, appearance, and body language, rather than the act of wearing clothes or delving deeper into how a character's psychology is affected by costume. The work fails to take into consideration how costumes convey visual leads of characters' personality and the different ways costumes influence characters' visual appearance and body language. However, Crafton does note an interesting intervention of costume design in relation to animators' performance with an example from the animated cartoon *Bugs' Bonnets* (Chuck Jones, Warner Bros., 1956). He points out that accessories function as visual signifiers of the character's personality and also stimulate the character's performance. Crafton (2013: 322) remarks that 'every time a hat falls from the Acme Theatrical Hat Co. truck and lands on a character, his behaviour and his personality change to fit the headgear.' Crafton nicely acknowledges the ways that costume not only stimulates ideas for character performance in animation, but also the power of costume in conveying differences between characters. Unfortunately, his example is only brief and leaves space for further elaboration around the idea of costume and animated performance. The discussion by scholars Crafton, Wells, Honess Roe, and Prince of the animator's performance offers a context and background information for my thesis. In particular in Chapter 3, I focus on the role of costume in the animated characters' performance and the ways costume assist the anima-

[12] The concept of embodiment is unpacked and further explored in Section 2.3 *Theoretical frame*.

[13] The concept of acting and animation is discussed in more detail in guidebook type of publications, such as by Derek Hayes and Chris Webster (2013) *Acting and Performance for Animation* and by Ed Hooks (2011) *Acting for Animators*.

tor in creating the performance, as part of the discussion on the absence of the actor in costume design development in computer-animated films.

Missing from animation studies is a discussion of the spectators' viewpoint in watching the animated performance and the ways that costume helps create an embodied connection between the character and spectator. By contrast, this is an area often discussed in the context of live performance and live-action films, for example, by film costume design scholar Sarah Street (2001). She remarks that in live-action films, the actor's performance is, of course, observed by and transferred to the spectator, in which case the 'costumes not only relate to the characters who wear them but also to the audiences who watch them' (2001: 7). The performance of the actor is embodied by the spectator, and costume enhances the connection of the character's feelings and emotions. On this point, in the case of theatre performance, Monks (2010: 24) argues for "visceral empathy," which means that costumes produce embodied reflections that emerge from the spectator's imagination and own experiences of wearing clothes. Monks shares an example of this when a spectator sees an actress wearing a corset and at the same time imagines the constriction and lack of breath such a costume generates. Therefore, not only are the visual signifiers of the character's personality transmitted to the spectator but also the embodied feelings of wearing costume. Trimingham (2017: 138) mutually points out that costume also impacts the mind that watches it, where the ways costumes are worn affect the spectator's way of understanding the feelings and emotions of the actor. Such features are not discussed in animation studies in relation to spectator and character performance, even though surely costumes facilitate characters' emotions and gestures, which are embodied by the spectators perceiving the character, as in live-action films and live performance. The concept of embodiment and the various ways that digital costumes transfer embodied feelings to spectators has provided theoretical support for my work, and I will delve further into this topic in Chapters 4 and 5. I will discuss the concept of embodiment in more detail in Chapter 2, section 2.3 'Theoretical frame.'

Drawing and real-life representation

The characters' performance in animation is developed and created by the animator through the act of drawing. Animators explore ideas for animated characters' visual appearance and their performance through drawn lines and figures, as well as create the performance through drawing. Since costume design is an integral part of characters' representation and performance, I consider animation drawing and real-life representation an essential part of costume design in animation. Different areas involved in animation drawing are explored further in Wells et al. (2009) *Drawing for Animation*, which states that drawing facilitates animators' visualisation of ideas and concepts, as well as develops the character movement. Drawing is connected to two areas in animation: exploring ideas for a character through drawing, and bringing the character to life through drawn movement that is facilitated by animators' own feelings and gestures.

The importance of the embodied and aesthetic connection of drawing in general is defined by anthropologist Tim Ingold (2010: 99) in the ways that drawing 'is about becoming,' hence, by 'aligning your own movements and gestures with those of the things you wish to draw.' This connects with the physical activity, the act of drawing, where animators bring characters to life through drawing and the embodied experience where animators create characters' performance. Animation scholar Birgitta Hosea (2010) has also written about the process and theories of animation drawing in relation to animation's digital shift. In her article, Hosea (2010: 354) argues that 'drawing is the product of a material process' and that '[i]t involves a tacit knowledge of tools and materials.' She also remarks that the medium of drawing is often assumed to be made with a pencil on paper, but in animation, other mediums such as crayons, ink, charcoal, and digitally generated drawn lines apply. From a costume design perspective, animation drawing is interesting because the development of costume ideas is part of finding ideas for character representation. Animator Stephen Silver (2017) points out in his interview that 'animators don't draw naked people... so everyone's gotta have some form of clothes on.' This quote clearly connects the animation drawing process with costume design, something that is not considered in animation scholars' publications. Silver intends to say that character costume design is present throughout the character development, where visual representation of the character and its performance is explored and animated through drawing. Costume gives existence to the character's clothed body. These previous remarks give some ideas that costume's visual and embodied connotations are part of the drawing process from the beginning of character design development where animators express ideas for a character's visual representation and performance through drawing.

The process of animation drawing includes observation where artists examine and interpret on paper by drawing what they perceive through vision.[14] Hence, 'perception is an important aspect of the imaginative process, in the sense that all drawing is predicated on seeking to execute physically what is being created in the mind' (Wells et al. 2009: 23). In order to draw from real-life references, animators observe and interpret examples from real life. Acting and performance is part of this observation in that animators observe performers, which then suggests ideas for character gestures, poses, or personalities. This then connects to costume design as when animators study performers, they also investigate garments on their body to be able to draw these in an authentic way, especially in movement. Such observation enables them to examine different types of materials, their weight, fall, and drape on a person and in movement, as well as the ways that light and shadow respond to moving fabric. Observing real actors' performances is often referred to as "live-action reference" or "motion study". Human motion from filmed motion study material traced over with ink or pencil is referred to as "rotoscoping".[15] Solomon (2015: 40) remarks that motion study reference works as a guide for animators to replicate the complex human movements, and 'actors wearing wigs and costumes' assists this process. The motion study footage is often filmed, and this footage is educational and helpful for the artists to point out important areas in character movement. Solomon (2015) continues that this kind of filmed motion study footage has been used across animation studios, for example in Disney's early hand-drawn animations such as *Alice in Wonderland* (Geronimi, Jackson, and Luske 1951), *Cinderella*, *Sleeping Beauty*, in the studio's later hand-drawn animations *Pocahontas* (Goldberg and Gabriel 1995) and *Mulan* (Bancroft and Cook 1998), and in more recent computer animations such as Pixar's *Toy Story 3* (Unkrich 2010). From Wells and Solomon's ideas on real-life observation and motion study process, I have clearly encountered another costume design–related topic in animation where physical costumes are direct references for the processes of character development and animation drawing.

Observation of real actors in movement for animation purposes is noted from a costume design point of view by film costume designer Joanna Johnston (2012) as part of her discussion regarding her costume design process on the production *Who Framed Roger Rabbit*. Her text is included in the edited volume by Nadoolman Landis (2012a) and is one of the only literature sources that specifically discusses costume design in animation from a costume designer's point of view. Johnston remarks that motion study was used in *Who Framed Roger Rabbit* production, for example, in scenes when actor Bob Hoskins performed with the animated character Roger Rabbit. Hoskins requested a physical reference to work with on the set, and stand-up comedian Charlie Fleischer who voiced Roger Rabbit was commissioned as the character's reference model. Johnston physically made Roger Rabbit's costume for Fleischer because it assisted Hoskins to visually perceive the character in the ways it represented the animated form (Johnston 2012: 295–296). The costume on the 'physical' Roger Rabbit helped the animators who studied the character to understand the character costume better in movement when Fleischer acted the scenes and to correctly draw movements, actions, and the costume of Fleischer as Roger Rabbit. Furthermore, the physical costume assisted Fleischer to understand the character better and to create his movements in a believable way. This demonstrates the importance of physical costumes for animators' observation, thus helping them more easily draw the character in accurate costume in the animation. Examining costume in movement allows a more truthful animation process that increases the believability of the character. Physical costumes also allow the performers to embody the character they impersonate, which connects with the earlier discussion on costumes supporting actors to better find their characters and facilitating ideas for performance.

In order to draw and interpret costumes accurately on motion study models, costumes are required to replicate their animated versions in their design and material. This suggests clearly that costumes connect with animation at a point when physical costumes are made specifically for animation purposes. In addition to Johnston's (2012) aforementioned example, the only reference in animation literature about making these physical costumes comes from Solomon (2014). He remarks that during the production of *Sleeping Beauty*, the costume for Helene Stanley, the motion study actor of the animated character Princess Aurora, was made by fashion designer Alice Estes Davis, wife of the character's principal animator Marc Davis. Mrs Davis recalls that 'Marc told me how he wanted the skirt to flow when she turned and gave me a sketch of the costume' (Solomon 2014: 51). Her statement

[14] Observation and especially interpretation are formed by the artist's 'background, knowledge and context, and the particular way in which the subject is imagined or remembered to be' (Wells et al., 2009: 22).

[15] More on 'live-action reference' and 'motion study' and its connection to costumes can be found in Allan 1999; Solomon 2014 and Solomon 2015.

regarding the flow of the skirt indicates that the materials used for motion study costumes are crucial for the costumes to be drawn accurately in animated character performance. No literature, however, indicates the process of making of these physical costumes nor the connection to drawing these costumes.

The topic of drawing has provided a foundation for my research to investigate how costume design is seen as part of animated character development, a phase when characters' visual appearance and performance are explored through drawing. The literature on motion study costumes provides only scarce information on character costume design in animation but does show a clear connection between physical costumes and the animation drawing process.

Costume design in the context of computer animation

From a historical point of view, the medium of computer animation first emerged in live-action feature films to supplement scenes with special effects and had little to do with character costumes. Film scholar Michele Pierson (2002: 123–124) notes in her book *Special Effects: Still in Search of Wonder* that film productions developed and employed computer-generated (CG) special effects to enhance the spectator's immersion in certain sequences. She remarks that the more frequent use of these CG effects resulted in such sequences being called "effects sequences" rather than simply film sequences (Pierson 2002: 123–124). Throughout the 1980s and 1990s, the CG effects concentrated on building imaginative environments to enhance the power and creativity of feature films. None of the effects in these films had any influence on building special digital characteristics in character costumes, and consequently no literature refers to computer-animated costumes. Computer animation is discussed by Pierson as a medium that takes film's visual representation to another level. The same is argued by Tom Sito (2013) in his detailed publication *Moving Innovation: A History of Computer Animation*, which charts the development of the computer animation medium and its subsequent implementation in animation and live-action films. Sito's publication argues that CG effects were constantly developed, tested, and employed in live-action films, hand-drawn animation, or in the creation of entirely computer-animated short films. Implementing computer-animated effects comprised embedding them to enhance specific scenes in hand-drawn animations such as Disney's *The Little Mermaid* (Clements and Musker 1989), *Beauty and the Beast*, *Aladdin* (Clements and Musker 1992), and *The Lion King* (Minkoff and Allers 1994). Sito (2013: 210) remarks that *Titanic* (Cameron 1997) represents one of the first films where completely digital environments that included characters were synced with live-action filming. Digital characters were multiplied for the sequence in which the ship sank. Hence, the "effects sequences" expanded from the creation of environments to characters, which then led to the larger integration of digital effects in films.

The medium of computer animation is further elaborated on in Christopher Holliday's (2018) *The Computer-Animated Film*, which was published while I was carrying out my data analysis. Given its focus on computer animation, it has been a useful source for writing my thesis. Holliday (2018: 35) argues that '[c]omputer-animated films do tend to convey a uniform three-dimensional visual style, despite the capabilities of digital technology for non-photorealistic rendering.' I find that Holliday's argument links with digitally created character costumes in the ways that the three-dimensional style contains all visual aspects in a film, including characters wearing costumes because character costumes tend to follow the same aesthetic style depicted in films' environments. From this argument, I see a point of departure for my analysis to focus on the delineation of computer-animated films' overall visual aesthetic design. Holliday (2018: 36) also notes that the aesthetics in those three-dimensional worlds that computer animation conveys are executed with a certain software that is adopted within the industry. Large animation studios, for example, Disney, DreamWorks, ILM, and Illumination Entertainment, all use Pixar's RenderMan program and Maya (Autodesk) for computer animation. As each of these companies uses the same program, their films share a similar graphical style. The similar graphical style expands to the design of character costumes, as they match with the visual style of the environments and the development of this software also connects with the creation of digitally animated costumes. Holliday's *The Computer-Animated Film* provides useful insights into the different areas of making computer-animated films, such as style, genre, collaboration, and performance, which I cite across the thesis. His discussion regarding collaboration, performance, and the aesthetic style in computer animation has

been particularly useful for my work in understanding these different areas of computer animation.

Pixar's *Toy Story* was the first feature-length computer animation, and therefore it has raised interest across animation scholarship. One of the publications centring on the film is *Toy Story. How Pixar Reinvented the Animated Feature* (2018), edited by Susan Smith, Noel Brown, and Sam Summers.[16] Focusing on the aesthetic style of *Toy Story*, the chapters by film scholar Lucy Fife Donaldson and animation scholar Heather L. Holian equally state that the concept behind the film – telling the story of toys – evolved from the fact that the available computer technology and software created surface textures on the characters that resembled plastic materials. Fife Donaldson's chapter 'Rough and Smooth: The Everyday Textures of Toy Story' examines texture qualities in the first *Toy Story* and points out interesting ideas on the relationship between texture and perception that inform how we might understand the development of costumes within a computer-animated film context. Fife Donaldson (2018: 80) remarks that 'the textural connections of the design of the world to its feel within the fiction further establish coherence in the way it connects our experience to that of the toys.' The quality achieved by the animation software in the depiction of plastic material was taken as a benefit rather than a parameter and was used to build the aesthetic style of the film. The digital reproduction of animated surface textures, especially the aesthetic design that computer animation conveys, is also discussed by Holian (2018) in her chapter 'New and Inherited Aesthetics: Designing for the Toy Story Trilogy One Film at a Time.' Holian (2018: 60) remarks that Ralph Eggleston, the art director of *Toy Story*, stated that underdeveloped computer animation technology affected the film's stylistic decisions. Plastic and wood are hard materials and therefore easier to accomplish with animation and were therefore chosen as characters' surface materials in the film. The stiff surfaces are also visible in character costumes, which are tight-fitting on each character's body, impacting and also limiting the character design. Of note, the bell-shaped skirt on the doll character is the only costume not modelled tightly on a character's body form, but the movement of the skirt is restrained and does not have the natural flow of a garment. Fife Donaldson's and Holian's arguments are useful for my thesis in understanding the relation of technology to different levels of realism in computer-animated films.

Remarking on the appearance of animated characters' surface textures, Fife Donaldson (2018: 80) notes that the texture for the toy characters' surface was executed in a way to create more depth and tactility on them, but also that they were different from one another to give distinct qualities to the characters. For example, surface textures on lead characters Woody and Buzz are contrasted by rough/textured and smooth/hard. Buzz is also clean and white, whereas Woody's surface appears worn. The arguments developed by Fife Donaldson and Holian in relation to how real material characteristics are reproduced in digital material texture surfaces serves as a point of departure for my analysis regarding the ways these material texture qualities are achieved in digital character costumes. It seems that with the aid of CG, there is a potentially greater focus and investment in a character's surface materials, but questions arise on how the same is created in character costumes. This has informed my work with the aim to focus on how costume materials and especially their textural characteristics are digitally produced in the case study films. I explore this topic further in both Chapters 4 and 5 in this thesis.

The development of computer technology, which is shown in advancements in animation software, has enabled animators to build more complex and richer textures for environments and characters. However, as Holian (2018: 68) points out, the plastic aesthetics that were established due to technology available during the production of *Toy Story* guided the art direction of the future films for visual continuity. In this case, technology set parameters for the aesthetic quality in the first film and the same continued in the sequels, even though the films could then achieve more textured and richer surface depictions. In the frame of costumes, surely such aesthetic choices dictated by technology also influence the design of costumes in computer animations. More recent films also confront issues with technology, affecting the quality of the visual aesthetics in the films. For example, in *The Art of Frozen*, Solomon (2013) discusses a number of technical challenges that affected the costume design during the production of *Frozen* (2013: 88). The sequel *Frozen 2* (Lee and Buck 2019) retained the visual essence of the previous film but updated the characters and environments with the newly developed animation software. Julius (2019: 16) also comments that Disney's Hyperion Renderer software increased the level of visual richness. They had

[16] In this volume, Noel Brown unpacks the popularity of *Toy Story* in his chapter *Toy Story and the Hollywood Family Film* (2018).

the 'ability to make things feel like the material they actually are' argued the film's look development supervisor Jack Fulmer. Such features are visible in character costumes in a more accurate realistic representation of materials in real life. Based on the previous scholarly and industrial remarks, there are two aspects that are connected to digital character costume design. First, the software development influences the design of the costumes. Second, the realistic depiction of real-life materials returns to the previously discussed topic of real-life representation in animation. This time, in these computer-animated films, the real materials are interpreted in digital form, instead of drawing them. These scholarly debates suggest that the medium of computer animation aims for realism and realistic depiction of costume materials, which has guided my research on the connection of real materials to the representation of digital materials and how the development of technology affects this process.

The literature on representation of digital material textural qualities in computer animation provides evidence that physical real-world materials are examined in this process. Johnston (2012: 296) shares one short reference regarding this topic as part of the production of *Who Framed Roger Rabbit*. In the animation process of Jessica Rabbit's shimmering pink gown, Johnston made a physical material sample of sequined fabric for the animator's examination. She explains that the material example enabled the animators to transfer the real material qualities in the CG version of Jessica Rabbit's gown (Johnston 2012: 296). This literature example suggests that observing physical material reference is connected to the digital reproduction of material qualities and textures in animation. Similar remarks are made in the context of *Avatar* (Cameron 2009), a film that is considered as a live-action film even though 80% of the film was computer animated through the use of motion capture technologies (Sito 2013: 214). In this film, the creation of CG costumes, especially for the imaginary N'avi people, required real-world references. The film's costume designers Mayes C. Rubeo and Deborah Lynn Scott made physical versions of the digital costume designs so that the costumes could be accurately produced in the computer animation process (Duncan & Fitzpatrick 2010). The earlier discussion on studying real garments on a performer in motion study practice connects with this kind of real material examination for the purpose of computer animation. Real material examination has introduced an industrial phase where costume design is evidently integrated. This aspect is also discussed by screenwriter John Hopkins (2004), who contributes just one page to the topic of costume design in animation in his publication *From the Swamp to the Screen*. In an interview included in the volume, costume designer Isis Mussenden, one of my thesis interviewees, explains that one of her first tasks in the production of *Shrek* was to find material samples for the animators. She remarks that '[i]t's good for the animators to touch the fabrics and get a sense of them.' Mussenden considered these material samples important for examination of colour saturation and the ways light reacts on a fabric surface (Hopkins 2004: 64). Hopkins' publication is important in the scholarship of animation as it recognises the work of the costume designer as part of the productions of *Shrek* and *Shrek 2*. However, Hopkins' publication lacks the connection between costume design to so many different areas of animated film production, such as character development and visual appearance of locations. Also, the discussion regarding Isis Mussenden's work towards the films' costumes is very brief, only written on a general level and noting only a few ideas that lead to the final design of the lead character's costumes. However, Mussenden's statement on the physical material experimentation connects with the other literature sources on physical real-life references and the ways these assist digital character costume design and creation of digital costume's textures. The relationship between physical, tangible materials and their digital reproductions seems to be central to computer animation; therefore, I explore this topic throughout Chapter 5. Concepts relating to physical/tangible and digital materiality and what they mean in the frame of this thesis are explored in Chapter 2, section 2.3 *Theoretical frame*.

The technical papers that deliver information regarding research development on technology and software within animation companies related to the creation of computer-animated films also share evidence on costume design. Specifically, these papers indicate how computer-animation software is capable of digitally creating different material behaviours, which further connects with creating costumes and material textures with CG. One such paper is by Priyamvad Deshmukh et al. (2017), which presents DreamWorks' "fabric shading model", a software that enables an authentic depiction of different fabric textures, such as silk, velvet, or cotton on digital costumes. The argument in this short paper is aimed at industry practitioners and supports their creation of different digital fabrics in certain lighting conditions. This paper is a useful reference for my research for connecting costume designs with the creation of the costume materials with animation

software, which I develop across the thesis. In a technical paper by Lawrence D. Cutler et al. (2007), the authors present a "wrinkle database" that the team developed for digital character representation in DreamWorks' *Shrek 2*. Their database enabled the creation of authentic wrinkles and folds on character clothing and multiplied them to different garments. This advancement facilitated a more accurate depiction of the physicality of real-world clothing. These two papers give examples of the issues in the reproduction of digitally animated costumes and software development. They provide a background for the key ideas on how computer-animation software affects the design and creation of CG costumes and how different physicalities of costumes are crafted with CG technology. These papers are written from the perspective of technical animators, thus offering another viewpoint, making them valuable comparative literature material for my analysis in this thesis by illuminating technological innovations and providing technical vocabulary for the study of costumes in computer-animated films.

One of the rare examples of published technical papers in animation in which pattern cutting, an area related to physical garment making, is explored in more detail is by Fran Kalal et al. (2009). The paper specifically discusses the Pixar film *Up* (Docter and Peterson 2009) and argues that traditional tailoring methods are applicable in computer animation; however, characters that have exaggerated body forms, like the round body of a young boy named Russell and square body shape of an elderly man Carl in *Up*, require specific pattern alterations for the CG costumes. The paper shows the different ways that patterns for traditional human forms were altered to create the different unusual shapes of the animated characters. This kind of literature offers insight into how digitally created costumes are constructed in computer animation. This is a phase when costumes are not only drawn over the character's body but constructed in a way that they resemble garment-making in real life, where a pattern shape creates the form of a garment. The ideas from this paper are useful supportive literature for my analysis of how costumes are constructed on the characters in the case study films.

Of all literature sources, costume designer Holly Poe Durbin's (2017) chapter on digital character costume design in an edited publication by Melissa L. Merz is the most comprehensive on the topic, but still very brief. The chapter focuses on the *Shrek* film franchise, centring on the work of costume designer Isis Mussenden. Durbin (2017: 252) argues that '[t]he role of costumes on characters began to change dramatically with the advent of CGI' and adds the first *Shrek* film as the 'landmark breakthrough for animated characters.' Durbin's remarks suggest that the medium of computer animation offers a place for a costume designer to engage in character development; as such, my thesis further explores this important topic. Durbin's (2017: 254) description of Mussenden's costume design in the *Shrek* films suggests that the creation of digital costumes requires understanding of different physical materials and the ways three-dimensional garments function on a body form, an area noted in the previously explored literature examples. Durbin (2017: 254), however, argues that even though computer animation enables the creation of imaginative designs, not everything can be built digitally. Different ideas for costumes might take too long time to animate, and therefore a budgetary issue exists of what elements can be included in digital costumes. Thus, this literature suggests that computer animation brings opportunities but also limitations. Durbin's chapter only briefly mentions these costume design–related aspects in computer animation. However, acknowledging the work of a costume designer in computer-animated film productions very much connects with my thesis topic. Durbin's perspectives on the use of physical materials in constructing digitally animated costumes support this key area of interest; as my evidence also supports this claim, I have expressly included the topic as one of my research questions.

The costume designer's involvement in animated films due to the development of technology is also discussed by costume design scholar Lauren Boumaroun (2018) in her article 'Costume Designer/Everything: Hybridized Identities in Animation Production'. Boumaroun agrees with Durbin that, due to the level of technical requirements in computer animations, there has been a certain demand for costume designers in the films. Boumaroun elaborates on the work of costume designer Kat Shea in animated TV series *Archer* (2009–2021) and Margaret Meyer's costume design in the stop-motion animation *Coraline* (2009). The article focuses on the practical work of the two designers, their long working hours, fast-paced hectic schedules, and the different tasks the designers are involved in. Boumaroun remarks that regardless of the after-effects made via computer animation, stop-motion animated films are strongly material-focused. Hence, the high level of material detail is put in the craftmanship and presentation of the stop-motion puppet costumes. This is in contrast to the hand-drawn animated TV series, which focus mostly on simplified form and stylistic consistency expressed

through the medium of drawing. The topic of detailed material depiction versus more simplified form in animated character clothing also merits elaboration in the case of computer-animated films. The insights in Boumaroun's article are important additions to the scarce literature on costume design in the various forms of animation. It also brings more awareness of the work of the costume designer in animation and provides comparative material for studies that focus on costume design in stop-motion and hand-drawn animated films.

Conclusion

This cross-section of literature has presented some of the key themes and central literature related to costume design in animation and the computer animation medium. However, many of the literature sources in animation tend to focus on the analysis of one specific film or film company. Literature focuses typically on the animated features produced by the Disney studio, while my thesis brings comparative literature especially from the perspective of DreamWorks animation productions. In addition, the technical papers focus on software used particularly within one production company, primarily Disney, Pixar, or DreamWorks. My thesis expands these findings to a larger context related to the design and development of costumes, and most importantly the skills, expertise, and labour of a credited costume designer.

As the literature in this chapter has shown, prior to the production of *Shrek* and the work of Isis Mussenden, elements that are considered part of the workflow of the costume designer were discussed as part of the character design stage of production, thereby making it difficult to attribute an animated character's costume design to an individual. The contribution of a costume designer in an animated character's costume design stands as the core of this doctoral thesis. Costume designers' work processes offer an avenue to investigate the role and contribution of a specific designer in computer-animated film productions, and through this viewpoint, the different areas involved in digital character costume design can be investigated and highlighted.

The examples from the literature offered notions to consider in my research from costume design in animation in general to specific areas connected to the medium of computer animation. Evident from the literature is that the visual representation of a character's costume in depicting character identity is connected with animated character development. Character development is a process in which animators' discussions on character identity and visual information from concept art are drawn to convey ideas for character clothing. My thesis takes an approach where I examine the various ways the costume designer develops ideas for character representation in the frame of computer-animated films. Costume design is evidently also linked with narrative contexts, such as the time and place in which the film is set. Different films present visual connotations of time and place via costumes; however, previous literature in animation has yet to explore this critical topic. I therefore investigate in my thesis the ways that costumes visually support narrative development, films' locations, and time periods in the case study films.

Regarding characters' physicality and performance, the existing literature defines the animator as actor and protagonist in bringing the character to life. My thesis builds on these existing debates regarding animation performance from the point of view of a costume designer and costume design studies. The referenced literature has also indicated that drawing and real-life observation are areas connected to animation and costume design. In this context, physical costumes, especially costume structures and materials, are examined in the animation process. My thesis offers a platform to study the relationship between real materials and the interpretation of such in computer animation.

It was evident from my review of the literature that the development of animation software affects the aesthetic qualities in computer-animated films. This is particularly visible in the depiction of different textured surfaces on animated characters as well as in the environment. Literature on this topic has provided background information that facilitates further investigation into how technology is visible in the costume design development as well as in the representation of the final digitally animated costume. The literature also indicated that examining physical garments and real-world material textures is part of computer animation. My thesis adds to this discussion of how physical references are part of costume designer's work and animating digital costumes in general. Real costumes are highly material, made with textures that can be felt by the maker and wearer (i.e., the actor), facilitating ideas of the materiality also for the spectator. In digital costume design in CG films, as a close examination of the case studies will exemplify, the physical material properties are conveyed by digitally copying their real versions. My

thesis expands the existing debates on realism with a discussion on the different ways that real materials and real-world references are part of digital character costume design.

The selected works in this literature review operate as the background study for my research, and the existing debates are intertwined with analysis in the coming chapters. In the following chapter, I present my methodological choices for achieving the aims of this thesis. As this is data-driven research, I then present the theoretical concepts I have formulated following the data analysis.

CHAPTER 2

CHAPTER 2

RESEARCH DESIGN

This doctoral research is a qualitative study, and this chapter explores the methodology and decision-making in my collection and analysis of empirical materials. Figure 2 visualises my research path and illustrates the topics in this chapter. The figure presents the starting point of my research: the research problem, prior understanding of the topic, and these two formulated the research questions, which I presented in the Introduction.

The first section of this chapter elaborates on the selection of case study films. The goal of this doctoral research is to examine the key characteristics of digital character costume design through the experience of professional costume designers who have been engaged in computer-animated films. Therefore, I have selected six case study films that engaged and credited a costume designer in the production, which I discuss in more detail in the first section of this chapter. Thereafter, in the second section, I present the data collection methods, including archival research, interview method and the interviewees, the definition of the interview questions, as well as research materials. In the third section of this chapter, I explore my analysis methods, which are defined as content, visual, and comparative analysis. Figure 2 illustrates these phases and materials. Last, I present the key concepts and theories that have informed my research. Each concept and theory stemmed

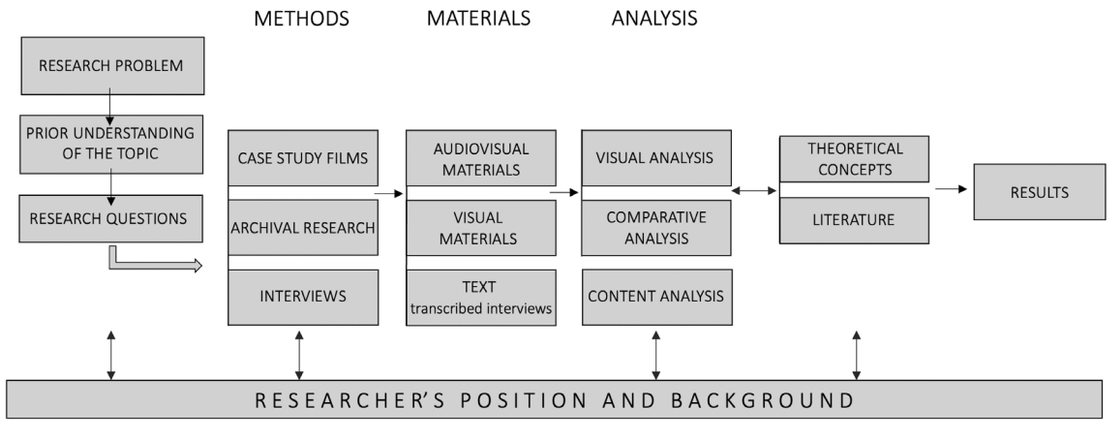


Figure 2. This figure illustrates my research path. From the research problem, questions, and prior understanding of the topic, I selected research methods to collect data, which generated my research materials. Thereafter, I analysed the data by embedding key concepts and theories in the analysis in later stages of my research path, which produced the research results.

from the data analysis, which is a feature of a data-driven research study. These key concepts and theories were intertwined with the analysis during the later stages of my research path. As Figure 2 indicates, I have also acknowledged my personal background in each step of my research path, as it relates to different stages of data collection, data analysis, and in synthesising the analysis with literature, key concepts, and theories.

2.1 Case study research

To discover the key characteristics involved in digital character costume design in a specific range of computer-animated films that included a costume designer in the film production, I used a comparative case study method and selected specific case study films. The nature of case study research, particularly with multiple case studies, involves emphasising a selection of cases (Bleijenbergh 2010, 61). I therefore focus on six films in which professional costume designers have been included and credited in the film production. The films' closing credits and the Internet Movie Database (IMDb) both indicate if a costume designers' contribution has been credited as part of the character process. I focused on the period between 1995, when the first feature-length computer animation was released, and 2016, when I started this doctoral research.

The case study films engaged costume designers in their production and therefore enable me to examine digital characters' costume design specifically from the costume designer's point of view. These case study films contribute to my aim of examining the input that professional costume designers specifically bring to computer-animated film productions. Since my research study focuses on films produced in Hollywood, these films represent mainstream Hollywood animation productions and have all been released in the same film market and within the same filmmaking industry. These commonalities contribute to a better comparative study between the films. The designers and case study films are Isis Mussenden and her work on DreamWorks' feature film productions *Shrek* (2001), *Shrek 2* (2004), and *Puss in Boots* (2011); Israel Segal's costume design contribution on *Shrek the Third* (2007); Ruth Myers' costume design on ImageMovers production *Monster House* (2006); and Danny Flynn's costume design on Disney Animations production *Big Hero 6* (2014). The films represent different studios, genres, and production techniques. Four of these films are fairy tales in the larger *Shrek* film franchise, and *Big Hero 6* is a science fiction adaptation of a Marvel comic book – all are created digitally. *Monster House* is a comedy-horror film achieved with a motion-capture technique. The release years between the case study films range from 2001, when the first *Shrek* premiered, to 2014, when *Big Hero 6* opened. The 13-year gap between these films offers me the opportunity to examine the films with respect to the development of technology, as animation software has significantly improved during this time. Thus, studying films during this range helped address my research question on the effects of technology development in computer animation over the years on the costume design process and the final outcome of the character costume.

2.2 Research data collection methods

Archival research

Archival research was one of the data collection methods used in my study, through which I collected audio-visual, visual, and textual materials from public and private archives. I sourced the preliminary literature in Helsinki, Finland, at the National Audiovisual Institute and Aalto University library. Further literature I collected in Los Angeles, at the Margaret Herrick Library, part of the Academy of Motion Pictures Arts & Sciences (AMPAS) archives. These locations provided access to more extensive literature regarding animation, CG filmmaking, and costume design, as well as copies of film reviews, interviews regarding film productions, and archived costume drawings from selected animated films. Furthermore, the Film & Television archive at the University of California in Los Angeles (UCLA) allowed me to study more closely the production of character animation through the work of cartoon animator Walter Lantz. His work informed my research by offering me a closer examination of the making of animation cels, storyboards, and background art. Lantz's work expanded my view of animation filmmaking to other sources than Disney animations. UCLA Arts library and The David C. Copley Center for the Study of Costume Design also proved fruitful for the literature collection, providing access to selected books and articles on animation and costume design.

As part of my background research for this thesis, I prepared and published an article on costume design in hand-drawn animation focusing on Disney's early animated feature films. Through this particular article research, I learned how costumes are traditionally designed in animation, as part of character development. I chose to focus on early Disney films, as those were the first feature-length hand-drawn animations that presented human characters who wore clothing. For this research, I requested access twice to the Walt Disney Animation Research Library and the Walt Disney Archives; however, my requests were rejected in both cases for reasons of either copyright, legal issues, and their high internal demand for these services. As a result, my research on the topic of this thesis relied on materials collected from outside the company, which were sufficiently useful for gaining an understanding of costume design in hand-drawn animation.

During my research process, I visited DreamWorks once to prepare a request to conduct further research at the studio, with the goal of interviewing professionals involved in building computer-animated costumes as well as artistic supervisors. Unfortunately, my access to the DreamWorks studio was also denied, due to legal and intellectual property issues concerning their copyright, trademarks, and trade secrets. I overcame this challenge by collecting the data solely from professionals working outside the company, contacting each of the costume designers who worked on the case study films and requesting an interview. This restriction on access to both studios, however, pushed me to access the designers' personal archive materials, including costume design development sketches, costume drawings, and their visual research materials for costume design development. These proved to be valuable materials and highly informative regarding the designer's costume design development, which is often an obscure phase in film production processes. The following section explores my interview research method and how I used the designers' personal archived materials in my analysis.

Interviews

In qualitative research, interviewing is a natural choice as a data collection method when the research focuses on different people's experiences primarily because it allows one 'to achieve the same deep level of knowledge and understanding' of the interviewee (Johnson and Rowland 2012: 101). Interviewing requires face-to-face interaction and a location that facilitates a profound interaction between the researcher and the respondent (Johnson and Rowland 2012). In my doctoral study, I have therefore selected semi-structured in-depth interviews as the principal data collection research and collected oral testimonies from the costume designers who have worked specifically on the case study film productions. In addition, I interviewed art directors, production designers, and animators who had either worked on the case study films or who had a robust career in the animation field. Their knowledge and contributions deepened my understanding of costume design in animation and provided more information on the collaboration of costume designers with the rest of the production team. I conducted interviews with 14 participants, of whom I selected eight for the final analysis in

this research. I chose to exclude six interviews because they failed to provide any further significant insights to my research, did not help identify central thematic areas, nor did they add information to the central understanding of the research topic.[17]

I selected interviews with costume designers Isis Mussenden, Israel Segal, Ruth Myers, and Danny Flynn because of their involvement in the computer-animated film productions chosen as my case study films for this research. Each designer possesses a different educational and professional background, which affects their design approach. Isis Mussenden led an extensive career as a film costume designer prior to *Shrek*, and she had previously collaborated with *Shrek*'s producer Aron Warner. Her academic study of the practice and history of classical art at the College of Creative Studies in Santa Barbara and fashion design at Parsons in New York is evident in her individual style of designing costumes, in which she combines design, construction, and functionality (Mussenden 2016a, 2018b). Warner saw the value of engaging Mussenden in the production of *Shrek* and their collaboration continued in the sequel. Mussenden moved on to *The Chronicles of Narnia: The Lion, the Witch and the Wardrobe* (2005) with *Shrek*'s director Andrew Adamson. Due to the need for a new costume designer, Israel Segal was selected to work on *Shrek the Third*. Similar to Mussenden, Segal had collaborated with producer Aron Warner prior to his employment in the animated film. Israel Segal's educational background includes writing and art history at the St. Lawrence College in NY State, which influences his implementation of narratives and history through visuals in his costume design development. Segal's professional career mostly included styling and commercial work as well as film costume design. Segal also worked as costume consultant on DreamWorks' two other computer animations: *Monsters vs. Aliens* (Vernon and Letterman 2009) and *The Croods* (DeMicco and Sanders 2013). However, his employment was terminated from these productions during early pre-production stage. Presumably, his contributions were included in the films' costumes; however, neither his designs nor input into the costumes were recognised in the films' end credits (Segal 2017a). For this reason, these two films have been excluded from this study but demonstrate how important accreditation is for revealing the contribution of a designer and identifying the phases and labour in the production.

Distinguished film costume designer Ruth Myers' work in the computer-animated feature film *Monster House* began through the film's director Gil Kenan, who was inspired by Myers' designs. They had also connected through previous collaboration with production designer Ed Verreaux. Myers was born and raised in Manchester, UK, and has worked on over 100 film productions. She studied illustration at St. Martin's School of Art in London and also took pattern cutting classes for her intended career as a costume designer. Her degree in illustration influenced her distinctive style of drawing, which she uses in sketching costume design ideas (Myers 2017, 2019). Costume designer Danny Flynn was employed in the film production *Big Hero 6* via an interview. Flynn owns the clothing store Replika Vintage in Los Angeles, which specialises in avant-garde designer fashion such as Yohji Yamamoto, Comme des Garçons, and Hussein Chalayan. The clothing in his store proved to be useful as an inspiration and were sometimes directly used as a reference in costume design for *Big Hero 6*. He grew up in San Francisco and San Jose, California, which he argues has influenced his design thinking. Prior to his work in computer animation, Flynn had an extensive career as a fashion stylist and designer for commercials and music videos (Flynn 2017). The differences and similarities between the interviewees' educational and professional backgrounds and approach to costume design in animation helped me draw conclusions on the predominant characteristics of costume design in animation.

In addition to the costume designers from the case study films, I interviewed professionals from the animation film industry to broaden my understanding of the aspects involved in character costume design. The interview with art director and production designer Guillaume Aretos was notable as it demonstrated the collaboration with costume designers in computer-animated films from the production designer's and art director's point of view. Among several other computer-animated film productions, Aretos worked on the case study films *Shrek*, *Shrek 2*, *Shrek the Third*, and

[17] I chose not to use the interviews with animators Caroline Hu, Melissa Piekaar, and Rob O'Neill, as well as art director/production designer Pierre-Olivier Vincent. This was chiefly because Hu discussed costume design for hand-drawn characters, Piekaar's work focused on stop-motion animation, and O'Neill and Pierre-Olivier Vincent currently work at DreamWorks and cannot provide statements without company permission. I did not include character designer Carter Goodridge's interview because his interview did not add any new insights into my pre-existing data. Costume designer Jouni Mervas worked on computer animation in Finland; therefore, the film and experience came from a different film market than the case study films, which are Hollywood productions. I chose to use materials from the interviews with costume designers Isis Mussenden, Israel Segal, Danny Flynn, and Ruth Myers, animator and professor Tom Sito, animator Stephen Silver, animator and costume designer Kelly Kimball, and art director/production designer Guillaume Aretos.

Puss in Boots. Animator and Professor Tom Sito's interview offered insight into animated film production processes from the perspective of an animator, character designer, and storyboard artist who has worked at both Disney and DreamWorks. Interviews with animator Kelly Kimball[18] concentrated mostly on her design of character costumes in DreamWorks' animations *The Prince of Egypt* (1998) and *Road to El Dorado* (2000). Kimball has a substantial career as an animator and has also worked as a costume illustrator in collaboration with film costume designer Deborah Nadoolman Landis. Her interview proved informative from an animator's perspective on character costume design development. Last, the interview with character designer and animator Stephen Silver enriched my analyses with a more thorough understanding of the integration of costume design into animated character design.

I chose the interview locations primarily according to where the interviewee had conducted their design work. Each costume designer conducted their design research and design development in a personal work studio or in their homes. Holding the interviews in these particular spaces supported a more open and relaxed environment. It also allowed the designers to present their own costume development designs and research materials during the interview. While the designers discussed their work, observing these visual materials helped them more vividly recall their work processes, contributing to richer research data. It also enabled me as a researcher to ask further questions about specific designs while the designers presented their costume drawings.

In-depth interviews are preferred in this type of research because they allow for reciprocity by the interviewer, who can reflect more freely on the information given than in any other interview format. This works well in conjunction with semi-structured interviews because they enable the researcher to build a structure for the interview questions; however, semi-structured interviews permit flexibility for further questions, interaction, and reflection. They also allow revision of some questions prior to, or during the interview, as well the order of the questions if needed, depending on how the interview proceeds (Saunders, Lewis and Thornhill 2016: 391). I have adapted this method to my research as it allows an open interview environment and

[18] Kimball is the daughter of animator Ward Kimball, one of Disney's main team of animators, known collectively as the "Nine Old Men".

modification of the questions if the interviewee answers some of the questions earlier.

In formulating the interview questions, a researcher cannot dismiss their background, previous knowledge, thoughts, and observations of the research topic (Eskola & Suoranta 1998, 187; Salo 2015, 172). Therefore, specific issues related to different phases in the costume design process were included in the interview questions, as this tacit knowledge stems from my own professional background. The kinds of questions on different aspects of the costume design process would provide answers to the main research question of identifying the key characteristics of costume design for digital characters in computer-animated films.

When data are gained through interviews, suitable interview questions lie at the core of acquiring rich and valid data. The data do not "answer" the researcher without the right questions being asked (Ruusuvuori, Nikander and Hyvärinen 2010: 15). I selected a list of primary interview questions seeking answers to larger thematic areas related to digital character costume design, alongside follow-up questions focusing on more specific aspects of the design process. I chose to use the interview questions available in the doctoral thesis *Scene and Not Heard: The Role of Costume in the Cinematic Storytelling* by Deborah Landis (2003) as they were specifically directed at demonstrating the different aspects of the process of costume design in live-action films. I discussed and revised these questions with Professor Landis to match them with the animation film productions and ensure they provided answers to my research questions. For example, the interview question pertaining to costume designers' research strategies offers answers on digital characters' costume design development. The question regarding the kind of visual and tangible materials given by costume designers to animators as references provides answers to the research question on how tangible materials are part of digital character costume design. I also included interview questions seeking information on the different ways each designer conducts costume design development: these included topics related to their academic and professional background and preparation for production meetings. The interview questions focusing on computer animation and animation software generate answers directly from the costume designer's perspective to the research question of whether the development of technology in computer animation affects the costume design process and the

final outcome of the character costume (see Appendix 1 for the full list of interview questions).

Berger (2015: 220, 223) notes that the researcher's background and position further impact interviews in that the researcher's own knowledge guides the interview, enabling them to ask further questions or to understand unfinished sentences. This experience corresponds with my interviews as my knowledge and understanding of costume design practice enhanced the interviews, often creating a collegial atmosphere of sharing a mutual understanding of costume design practice. This built trust between us, and the designers appeared confident, relaxed, and open in their answers. As I was able to understand the terminology and process of costume design, the designers explained their experiences more elaborately and in greater detail, enhancing the richness of the interview data.

In 2016, I conducted the first set of interviews during my first research visit to Los Angeles. I interviewed costume designer Isis Mussenden at her work studio in her home, focusing in the first interview on her work on *Shrek* and on *Shrek 2* in the second. During the same year, I made a second research visit to Los Angeles, in which I conducted the third interview with Mussenden. This interview included follow-up questions that I formulated after reading the transcribed interviews and gaining a preliminary understanding of her costume design work in computer animation. The next set of interviews was arranged in 2017 during my third research visit to Los Angeles, which included an interview on *Shrek the Third* with costume designer Israel Segal at his home. I also interviewed costume designer Danny Flynn at his clothing store Replika Vintage, focusing on his work on *Big Hero 6*. Animator Tom Sito agreed to an interview at his office at the University of Southern California (USC), where he works as an animation professor. Additionally, I interviewed animator and costume designer Kelly Kimball at her home studio in Altadena, California. In 2017, I also conducted interviews with animator Stephen Silver via Skype and conducted a phone interview with costume designer Ruth Myers and production designer Guillaume Aretos. I arranged the last set of interviews in 2018 via Skype with costume designer Isis Mussenden. This time, the interview concentrated on her work on *Puss in Boots*. I then also conducted another phone interview with Ruth Myers and sent follow-up questions via email to Israel Segal. Each interview was recorded, regardless of the medium, whether face to face, Skype, or phone. During each interview, the participants provided either written or oral consent to use their names in published materials, in the interview transcripts (in direct or indirect quotes), and in relation to the visual materials (where applicable) in the published thesis, journal articles, and conference papers that resulted from this study.

Research materials

Oral interview materials

The recorded oral interview data were transcribed, and this transcription text functioned as the principal research material. The length of the recorded oral interviews of eight participants was 15 hours and 58 minutes. The recordings were transcribed, during which the focus was on relevant content, significant pauses, and evidence of strong emotions such as laughter. Minor nuances and repetitive words were ignored, as I was more interested in what the respondents said (content) than how they said it, unless there was strong emphasis in the response.

Visual and audio-visual materials

The visual materials comprise the costume designers' personal research materials that they collected during their work process and used in the animated character costume design development. These materials included, for example, historical visual research such as copies of books and magazines illustrating fashions and textiles from certain periods, tangible material references, and garment pattern books. In addition, costume drawings proved to be valuable visual materials including either quick sketches made during the costume design development or more refined drawings that were presented in collaborative design meetings. Final character costume drawings illustrated the final decision on character costume design. Audio-visual materials consisted of the case study films *Shrek, Shrek 2*, *Shrek the Third*, *Puss in Boots*, *Monster House*, *Big Hero 6*, which were viewed either on DVDs or accessed on Netflix. YouTube video documentaries and short interviews on the making of computer-animated films broadened my understanding of the processes and decisions involved in the film production process.

The visual research materials offered by the costume designers proved extremely valuable for the analysis and research findings as they provided essential information on the techniques used by the costume designers in developing the characters' costumes. These also functioned as comparative research material with the computer-animated films, which illustrated the

final outcome of the character costume. Tangible material references gave information on textures and other physical material qualities, which were needed in the costume design development process and used as references to create these material qualities in the digital costumes. Together, they revealed the process of digital character costume design, from the first design ideas to the final result. Comparing the outcome of the character costumes in the case study films makes it possible to spotlight visual differences in visual aesthetic design among the films. In addition, comparison calls attention to the quality of the digital images, that is, how accurately the costumes represent their real-world versions.

2.3 Methods for data analysis

This research is data driven, and my findings are based on analysis and interpretation of the collected research data. Methodologically, this means that the researcher interprets the data and seeks to identify and describe different themes that emerge from the data and then connect them with the research topic (Varto 2005: 136). The interpretation method stems from hermeneutics, which includes the researcher's prior knowledge and understanding of the interpretation. Interpretation is a way to uncover human experiences and their meanings, which eventually form the research results (Laine 2010: 30-31). In my interpretation, I do not neglect my personal background and experience in costume design; it is present when I study the data. My knowledge is at hand when I examine the costume drawings, tangible materials, and costumes in the films, as I focus on costume structures, how they might have been made, and material choices. Influenced by my background, I also look at historical ideas related to period costume design. Willig (2013: 141) remarks that 'the interpreter has the power to shape what comes to be known about somebody's experience.' If the interpretation was formed by someone else, the results might have been different. I interpret the designers' experiences from oral narratives transcribed into textual form (interview transcriptions) and seek meanings that convey the different notions of digital characters' costume design. For this research, I have chosen content analysis to identify larger thematic areas and smaller concepts that illuminate the key characteristics of digital character costume design. In addition, I conduct visual and comparative analyses in order to strengthen the content analysis results and to uncover similarities and differences in

costume design development and the final outcome of character costume design.

Content analysis

To achieve the aim of this research – to examine the key areas involved in digital character costume design from the viewpoint of costume designer and their design processes while working on computer-animated films – I have selected a qualitative content analysis method to analyse the transcribed interview data. Content analysis remains one of the traditional procedures for analysing textual materials. It is an approach that creates indicators from the text that highlight themes, categories, or issues, which can be interpreted, assessed, and modified by the researcher during the analysis process (Weber 2011; Flick 2009: 323). Content analysis also uses thematic categories that emerge from the interviews (Flick 2009: 216). This method allows me to combine larger thematic areas that surfaced from the interviews, including the thematic areas that stemmed from the existing literature.

The selection of categories for the content analysis coding was decided upon from a cursory reading (Weber 2011). This enabled me to understand the whole context and to identify larger thematic areas, concepts, and patterns repeated in the discussions on digital character costume design. While evaluating these categories for the coding, I also kept in mind the research questions. Thus, the ideas and concepts that I drew from the literature review informed the direction of my analysis.

Based on the available content, I identified seven coding categories and used colours to highlight the areas (in the transcriptions) involved in each category. The categories emerged from the research questions, the material on the content, and the ideas that stemmed from the literature review. The first two categories focused on the respondent's educational and professional background and the start of their career. This content assisted in the evaluation of the different ways each designer works. The third category pertained to costume design process–related aspects, such as visual research, drawing, and what kind of issues inspired or influenced their costume design development. This helped identify some of the different areas included in digital character costume design. The fourth category indicated any technological issues in the costume designers' work, which provided an-

swers to the research question on how development of technology affects costume design. The fifth category concentrated on the use of tangible and visual material references in the design process, which provided answers to the research question on tangible materials in digital character costume design. The sixth category highlighted how costume designers collaborated, at the same time corresponding to interview questions related to collaboration. The last and seventh category spotlighted any information that referred to the animation medium or history and was mainly used in interviews with animators Tom Sito and Kelly Kimball, who both brought to light historical aspects and work processes in animation. Some of the information in the interviews overlapped between the categories.

By using those seven categories, I performed the coding. According to Weber (2011), the researcher should define the degree of coded text prior to coding. In my case, in order to identify larger concepts in digital character costume design, I focused on more significant chunks of text rather than specific words or individual sentences. I colour-coded these larger chunks of texts according to the information in them. Following this, I re-read the coded texts for further analysis, which every time revealed more detailed information and issues involved in the research topic.

In content analysis, any errors in reliability are reduced by focusing on the number of repetitions of larger themes, concepts connected with the themes, and individual statements that are similar to one another. The content analysis method suggests summarising the same paraphrases with the same meanings to reduce the analysed material (Flick 2009: 325). However, I decided not to undertake this approach, as summarising reduces each respondent's personal views and conveys the oral testimonies on a more abstract level. The investigation and analysis of personal oral testimonies give a voice to the designers, who are, in fact, the key persons holding information about the nuances of costume design in computer-animated films.

Varto (2005: 146) remarks that the themes emerging from coded data are an essential part of the research, as those themes evolve into research results. It is also essential to re-assess the themes as the research progresses, although the re-evaluation should again arise from the research data. I similarly revisited the research data and re-evaluated my previous interpretations by re-reading the coded interviews and analysing these together with the visual materials. Revisiting and evaluating the analysis and interpretation follows a methodological pattern similar to the hermeneutic circle.

Schleiermacher, the founder of hermeneutics and the concept of the hermeneutic circle, described the process by arguing that 'the parts can only be understood from an understanding of the whole, but that the whole can only be understood from an understanding of the parts' (Schmidt 2014: 4). Revisiting the parts means first gaining the basic level of understanding of the data, which creates a foundation for the research. This is followed by several revisits to the data in order to elaborate and discover the different meanings behind the data, as well as to demonstrate the key aspects that answer the research questions (Schmidt 2014: 4). The hermeneutic circle process is apparent in my research in my first gaining a preliminary understanding of the topic and then revisiting the research materials several times. As a consequence, I acquired a preliminary understanding in two ways: first, through literature research on the history of animation and the computer animation medium, animated character development, and computer-animated film production processes, and second, reading all interviews to gain another level of understanding of the research topic, prior to performing the content analysis coding. After the content analysis coding and thematising, my analysis and interpretation focused mostly on process descriptions, that is, what happened at each stage of the designer's costume design development and why. Thereafter, I revisited the research materials (coded interviews and visual materials) several times to re-evaluate, interpret, and contextualise the information, as well as connect it to wider theoretical concepts, as I will explain later in this chapter.

Several interpretations and analyses facilitated identification of larger thematic areas that offered answers to the research questions. These topics pertained to collaboration, technology, and tangible materials, which were eventually formulated as thematic areas for the main chapters in the thesis. The thematic area of collaboration involves the collaboration of costume designers within animated film production, during costume design development. The costume designers mutually shared information on those with whom they collaborated, at what stage of the production the collaboration occurred, and the outcome of these different collaborative relationships. The details of this theme directly answer the main research question regarding the key characteristics of costume design for digital characters in computer-animated films. The theme pertaining to technology encompassed costume designers' statements on the computer animation medium. Each costume designer expressed how animation software and the fact

that they designed for digital characters influenced their design decisions and process. The responses directly answer the research question of how development of technology in computer animation affects the costume design process and the final outcome of the character costume. Some of these results also answer the main research question on the key characteristics of digital character costume design. The theme related to tangible materials refers to real-world materials, mainly garments, fabrics, and other tangible materials. Use of tangible materials as a segment of digital character costume design was included in each costume designer's work process. In addition to answering the main research question regarding the key characteristics of digital character costume design, this theme provides answers to the research question on inclusion of tangible materials in digital character costume design.

My techniques for analysis and interpretation of the coded interviews also correlate with the phenomenological hermeneutic approach, in which the researcher stays close to the analysed data and ensures that their analysis stems from the interpretation and not from pre-existing theory or hypotheses (Willig 2013: 143). My analysis was performed similarly, and my data analysis and interpretation reflected my past professional experiences and knowledge, while being based on the collected data in a data-driven research study. The interpretation and findings from the content analysis were also studied with information gained through visual analysis. I explore this method in the following section.

Visual analysis: visual and audio-visual materials

The analysis of both visual and audio-visual materials comprised a qualitative, descriptive analysis method focusing on specific topics of analysis in the materials, which I further explore in this section. This analysis translates visual materials into words and enables exploration of certain aspects in these specific materials, as well as a comparison. The substance of digitally animated costume is highly visual; therefore, analysis of both visual and audio-visual materials is integrated into the findings of this study. This analysis centres on the pre-production and production materials including costume drawings, costume design development drawings, costume designer's personal research materials, and photographs that I took of each designer's research materials. Audio-visual materials include the case study films.

In the interpretation of visual and audio-visual images, not only is the image itself important, 'but *how* it [image] is seen by particular spectators who look in particular ways' (Rose 2001: 11, author's emphasis). Rose's (2001) approach specifically stresses the personal lived experience in interpreting an image. Berger (1972) underscores that 'we never look at just one thing; we are always looking at the relation between things and ourselves' (1972: 9). Likewise, in this research, my interpretation of the visual images is formed by my background as a costume designer and dressmaker. The hermeneutic research approach acknowledges the researcher's background and perspective in the analysis (Willig 2013). This viewpoint or lens clearly affects my research; my examination is influenced by knowledge gained through my costume design practice, previous research projects on historical costumes and digital reproduction of historical garments, teaching theory, and practice of costume design as well as costume and fashion history. Consequently, my expertise in garment construction from a two-dimensional pattern to a finished three-dimensional product forms part of this analysis. For example, I point out historical influences in costumes, as well as how character costumes reflect the character's identity and the larger context of a narrative.

In the visual analysis of the character costumes in the case study films, I focus on the costume's construction, form, and details such as embellishments and accessories. Similar aspects are also analysed in some of the visual material references used by costume designers as design inspiration in their costume design development. I also analysed tangible material references by examining their texture, material properties such as weight and thickness, and the digital reproduction of these same materials. This analysis is important for noting specific costume structures and material choices, and how the reproduction of these elements was achieved in the animated film. Studying these elements brings forward specifics of the costume design development process and the final outcome of digitally animated costume across the case study films.

The analysis of audio-visual materials, which are the case study films, concentrated on selected character costumes as an individual image and character. I selected the character costumes based on the interviewees' directly referring to these characters and/or their costumes, which enabled a

more thorough and richer analysis.[19] I paid attention to details in the costume structure, in addition to its texture, colouring, and silhouette. I also examined how selected costumes visually represent characters' identity, where aspects such as their social class, personality, or importance in the film are visible in the costume. In addition to individual characters' costumes, I also analysed some of the character groups in a similar way. This analysis provided additional visual information that supported the costume designers' testimonies regarding designing costumes for the 'extras,' the background characters.

The visual analysis of costumes on individual characters and on character groups also used what Rose (2001) calls 'compositional interpretation.' This 'remains a useful method because it does offer a way of looking very carefully at the content and form of images' and 'the compositionality of the image itself' (Rose 2001: 37–8).[20] The compositional areas of focus in my analysis were the design of costume and its relation with larger concepts in the film, such as the style of the environments/backgrounds, the geographical locational settings, and time periods. The design itself includes the form (silhouette), structure, details, colours, and material choices. In the case of some of the individual characters, I also analysed character costume changes, or the lack, and how these are accomplished in film sequences. This particular analysis theme stemmed from the interview data and from examining audio-visual materials. Results indicated that characters in computer animation typically do not change costumes to reflect changes in the narrative.

The large number of visual materials proved informative in this analysis process. I was able to analyse several costume drawings, tangible material samples, and the case study films, which all provided a clearer view of the research results. They connected to each of the research questions and contributed details on the characteristics of costume design for digital characters, the development of technology in computer animation and its effects on costume design, and the inclusion of tangible materials in digital character costume design. In addition, comparative analysis of visual and audio-visual materials revealed the differences and similarities of costume

[19] I also selected some of the costumes for the analysis based on their being the most convenient to visualise the case, analysis, and/or research result.

[20] For more on compositionality of an image as part of visual analysis, see Rose (2001).

design development in the different case study films. I explain my use of the comparative analysis method in the following section.

Comparative analysis

Qualitative comparative analysis is central to research studies when analysis seeks to gain information regarding similarities and differences in data. It is typically used in research studies examining the experiences of different people. Furthermore, a comparative analysis is primarily beneficial in case study research (Mills 2008). I included comparative analysis in this research to discover differences and similarities between the works of different designers, as well as the case study films. Via this method, I was able to compare all research materials with each other, including the visual and audio-visual materials and the costume designers' oral testimonies. The 13-year range in release dates of the case study films facilitated a comparison between them, specifically in the effects of the development of technology on costume design development and the final outcome of the digital costumes.

In a comparative analysis, comparison involves taking one entity or theme of the data and comparing it across the research materials. I undertook this approach in my research: for example, by specifically examining the theme of the development of technology in animation and comparing how this is visible in digital character costume design in the case study films. In the case of audio-visual materials, I examined the success of the final outcome of the digitally animated costume, including the complexity of the design and the result of costume material textures. The oral testimonies were also informative on this topic; therefore, comparing those with the costumes in the films allowed me to better highlight the results. This comparative analysis provided answers to the research question regarding the development of technology.

The observations and remarks from analysing the audio-visual materials were assessed against the visual materials, such as costume drawings and costume designers' visual and tangible research materials. I also compared these with the costume designers' oral testimonies. Combining these materials allowed me to highlight how the costume designs evolved as digital character costumes. For example, costume designers' oral testimonies referred to specific design elements that were visually evident in each costume designer's costume drawings. In addition, from the costume drawings I could

identify design suggestions for character costumes that could be compared with the final digitally animated costume. From this evaluation, I could highlight costume design development differences and similarities between the drawings and realisation of digitally animated costumes. Thus, this analysis contributes answers to each of the research questions.

The comparative analysis of visual and audio-visual materials and the interview data similarly followed the hermeneutic circle pattern. Revisits to data challenge prior interpretation, from which emerge new meanings for earlier findings (Schwandt 2007). I revisited and examined the visual materials multiple times during this research; each analysis and interpretation produced a new and more profound understanding of the topic. The final reassessment of research materials involves the researcher evaluating the results against existing literature (Paterson and Higgs 2005), which I also applied in my research by employing literature to discuss the findings. Synthesising the content, visual materials, and comparative analyses with literature helped me identify key concepts and theories that are connected to the study. I explain the theoretical framing in the following section of this chapter.

2.4 Theoretical frame: Key concepts and theories employed for the study of digital character costume design

In a data-driven research study, the theoretical framing stems from the main thematic areas that emerge from the interview analysis. As Varto (2005: 90-91) points out, the nature of hermeneutic interpretation is not to test an existing theory or to reflect any theories during the interpretation, as these would falsify the results. Similarly, in my data analysis, I reflected on the chosen theoretical concepts after contextualising the key themes from the data analysis that pertain to digital character costume design. This section outlines the key concepts and theories employed in my discussion throughout the following thesis chapters and how they connect with each chapter topic as part of my analysis and findings. Each of the theoretical concepts I have chosen arises from the designers' oral testimonies, blended with an analysis of visual and audio-visual materials.

Figure 3 illustrates the key theoretical concepts used in my discussion in this thesis. The figure illustrates the three main concepts, which all are connected. As indicated, the theory of somaesthetics (Shusterman 1999) and the concept of sensory perception (Shusterman 1999; Marks 2002; Prince 1996) function as umbrella concepts for the theoretical framing. They relate to the remaining two concepts: embodiment (Monks 2010; Crafton 2013) because somatic experiences are connected to the embodied experiences; and materiality (Ingold 2013; Harris 2013), which connects to somaesthetics, sensory perception, and embodiment in how materials are understood by different sensorial experiences such as vision, touch, and embodied experience through the body. These concepts also mesh with computer animation's ability to produce senses that are typically experienced through touch. I first explore the theory of somaesthetics and concept of sensory perception and thereafter discuss the theoretical concept of embodiment, and then the concept of materiality.

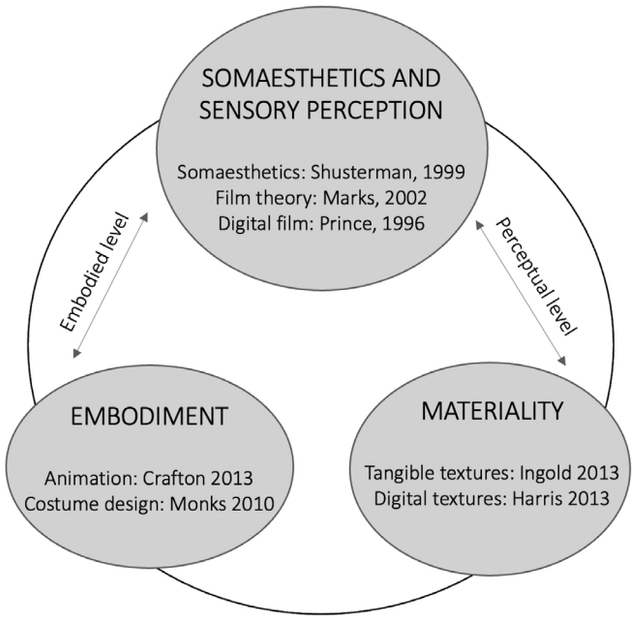


Figure 3. Theoretical framing and the relation between key theories and concepts.

Somaesthetics and sensory perception

Somaesthetic theory founder Richard Shusterman (1999; 2012) argues that the "soma" has a role in the body's external representation and is thus also important in the lived experience where 'somaesthetics works at improving the awareness of our bodily states and feelings' (1999: 299, 302). Shusterman (e.g., 1999, 2008, 2012) often speaks of soma rather than using the term "body" because body connotes more the physical corpus of flesh and bones, whereas soma includes aspects of living, feeling, and sentience. In this thesis, I also use the term soma in cases where I discuss issues having broader meanings than describing a body figure (both digital and human), for example in connection to the designer's personal somatic feelings and emotions that guide their design development. The term somaesthetics stems from the connection between somatic and aesthetic notions; hence, Shusterman (2012: x) argues that 'art cannot be created or appreciated without using our bodily senses, actions, and experience, so our lives must be inevitably lived somatically.' The concept of sensory perception derives from somaesthetics, where the term "sensory" is connected with the physical senses of touch, smell, taste, hearing, and sight. Sensory perception joins the physical senses with multisensorial experiences, which are involved in my research as part of the designer's input into costume design and the spectator's means of perceiving the character and their costume. In my research, I explore the ways somatic and tactile senses are present in digital character costume design and link somaesthetic theory and the concept of sensory perception with the costume designers' oral testimonies, as well as the analysis of visual and audio-visual materials.

Somaesthetics has been previously applied as a framework in the three general areas of design technology, politics, and arts. Shusterman (2012) notes that somaesthetics can be included in a range of collaborative, interdisciplinary, and transcultural analysis. For example, in theatre, somaesthetics provides a tool to examine actors' movements on stage. In one of Shusterman's (2012: 9) analyses, he explores somaesthetic ideals of movement and posture in Japanese Noh theatre. In other visual arts, somaesthetics enhances the analysis of artists' use of their own bodies to create artwork and the somatic experience of the viewer who visually observes and perceives the artworks (Shusterman 2012: 8, 9). Somaesthetics is visible in practitioners' work using both somatic and aesthetic notions as part of their practise, which can be representational, experiential, or performative (1999: 306–7). Shusterman (2008: 26) argues that 'most somatic practises have both representational and experiential dimensions,' including both inner and outer aspects. Therefore, somaesthetics specifically suits this study as it does not seek to draw a distinction between representation and experience. Costume design is also a practise that is representational, experiential, and performative, as well as including both aesthetic and tactile dimensions. Each designer has their own somatic and aesthetic experiences that guide their decisions in their work and their development of character costumes. Costume designer and scholar Sally E. Dean's (2016) practice on somatic costumes exemplifies work that can be also examined through somaesthetics. She has developed a performance methodology and Somatic Costumes trademark 'that bring awareness to different body types as well as generate different movement qualities and experiences in the body-mind' (Dean 2014). Practitioner and scholar Haya Cohen (2014) draws on lived experience and emphasises the interdependency of materials by arguing for a similar somaesthetic approach to Shusterman, that the body of the artist is included in artworks at some level. The previously mentioned scholarly publication of Melissa Trimingham (2017), 'Agency and empathy: Artists touch the body,' discusses the embodied emotions that wearing costumes transfers, which are also somaesthetic concepts. In relation to costumes, Shusterman himself has explored costumes through the framework of somaesthetics in his experiment *The Man in Gold* (2016). He argues that the lived experience of wearing costume transfers embodied feelings that affect the soma and the mind. Eric Mullis (2020) has further explored Shusterman's *The Man in Gold* experiment through his experience being a dancer-choreographer by adding the phenomenological approach to the analysis. These multidisciplinary approaches, including costume design and practice, show the application of somaesthetic theory in costume design. I contend that somaesthetics as an approach can be similarly used to explore the costume designers' somaesthetic relation to their work in computer-animated films.

In this thesis, I employ Shusterman's somaesthetic framework, particularly in Chapter 5 as part of the discussion on how and why costume designers use tangible materials, patterns, and garments in digital character costume design. Where 'somaesthetics can be provisionally defined as the critical meliorative study of one's experience and use of one's body as a locus of sensory-aesthetic appreciation and creative self-fashioning' (Shusterman

2008:19), the same is examined in the frame of tangible material exploration as part of digital character costume design. I am interested in how touching materials and different material functions, such as weight, texture, and flow, affect the designer's design choices. Regarding examination of tangible and visual materials, Shusterman includes the concept of sensory perception as part of somaesthetics by arguing that 'the senses surely belong to the body and are deeply influenced by its condition. Our sensory perception thus depends on how the body feels and functions, what it desires, does, and suffers' (1999: 301). He continues that the aesthetic perception is dependent on the bodily feelings, and that 'somaesthetics highlights and explores the soma – the living, sentient, purposive body – as the indispensable medium of all perception' (Shusterman 2012: 3).

Similar to Shusterman, film theorist Laura U. Marks (2000, 2002) emphasises the multisensory quality of perception in her writings focusing on the experience of cinematic viewing. Marks (2000: 132) suggests that 'a form of visuality that yields to the things seen, a vision that is not merely cognitive but acknowledges its location in the body.' Marks' calls this "haptic perception," similar to Shusterman's concept of sensory perception. Marks (2002: 2) defines the concept of haptic perception 'as the combination of tactile, kinaesthetic, and proprioceptive functions, the way we experience touch both on the surface of and inside our bodies.' Both haptic and sensory perception are concepts that identify haptic and sensorial experiences in the soma through vision. In addition, in relation to haptic perception, Marks (2002: 2) also introduces a concept of haptic visuality, in which 'the eyes themselves function like organs of touch.' Therefore, vision is unified with the bodily experiences such as touch and feel; what we see is felt in the body. She continues that 'haptic visuality draws on other senses, the viewer's body is more obviously involved in the process of seeing' (2002: 2). Marks draws her ideas from Vivian Sobchack (1992), one of the first scholars to merge phenomenological enquiry in film studies. Sobchack (2004) also discusses similar issues to Marks and Shusterman, including embodiment and the multisensorial effect of vision. In sum, the concepts of sensory and haptic perception, as well as haptic visuality are each somaesthetic concepts, which I draw on in this thesis to examine the presence of the multisensory quality of perception in the design development, production, and reception of digitally animated costumes.

Regarding reception and spectators' understanding of digitally created costumes (and digital environments), I discuss film scholar Stephen Prince's (1996) remarks on "perceptual realism" and spectators' understanding of the realism of cinema's very first digital images. Prince (1996: 29) writes that digital imaging challenges indexicality of photographic realism. However, 'a perceptually realistic image is one which structurally corresponds to the viewer's audiovisual experience of three-dimensional space.' In the case of perceptually realistic digital images, Prince (1996: 33) argues that they are 'convincing photographic realities because of the complex sets of perceptual correspondences that have been built into these images.' In short, the digital perceptual cues about surface texture, colours, motion, and distance establish 'correspondences with the properties of physical space and living systems in daily life,' which can be identified as perceptual realism. Similar to live-action photography, digital images in computer-animated films also generate multisensorial experiences through vision.[21]

These concepts offer a perspective for my analysis particularly during the phase when visual references were employed in the development of digital characters' costume design. Visual references are observed and felt through vision, and the experiences that perception transfers to the creators of animated characters are specifically used in digital character costume design. I mainly explore these aspects in Chapter 3 in the discussion of the role of visual materials in the collaboration between the costume designer and the film's production team, as well as in the Chapter 5 discussion of the designer's selection of visual references in costume design development. I also use multisensory experience of perception and the power of perceptual realism in my analysis of the final outcome of the digital characters' costumes, explored further in Chapters 4 and 5. Sensory and haptic perception connect with the embodied experience and the concept of embodiment, as the experience of looking expresses feelings that are felt in the soma, the body.

Theories of embodiment

Previous studies on the concept of embodiment and the connections between body and costume in the context of live or screen performance recog-

[21] The replications of real world in digital images is termed "photorealism".

nise that a particular costume assists the actors to find their characters; this is something that often happens during costume fittings or during rehearsals (see for example Howard 2019; Nadoolman Landis 2012a, 2012c, 2003; Pantouvaki 2010). Costume enables the actors to elaborate on emotions and feelings, as it affects their breathing and movement, reflecting an actor's physicality and performance. The costume also psychologically influences their feelings about themselves and their relationship with the character. The actor's body expresses the character's feelings, as the physical movements are connected to psychological emotions.

In addition to the embodied feeling that the costume transfers to the actor, spectators embody the character's feelings through the actor's body language. On this point, Monks (2010: 33) remarks that 'the audience gain imaginative access to actors' bodies through their costumes.' This refers to the ways that the actor embodies the character's psychological self through the costume and expresses these feelings to the audience. Costume reflects the performance visually, functionally, and physically. An actor's performance is perceived by the spectator, who embodies the actor's feelings and emotions, that 'is often mediated by the feelings created by wearing clothes' (Monks 2010: 24). I take Monks' approach in this thesis as part of the discussion on the spectator's perception of the character through their three-dimensional form and shape and the ways the spectator embodies the actor's performance and shares the same feelings as those of the actors. I reflect on how the character costume affects the performance and presents information about the character, which is connected to materials and their sensation on the body.

In animated character creation as well, the animators have been understood to embody the characters, whose psychological nature, as well as physical and visual appearance, are constructed during the character development. Donald Crafton (2013) discusses the concept of embodiment in connection with forms of performance in animation, where embodiment is especially visible in the animated characters' design and animation process. He emphasises that during a character's performance on screen, they act out the animator's movements and emotions. The animators deliver the performance to the characters through their own embodied feelings and gestures. He argues that 'the animators *are* the characters. They try to "live" them much as human actors, through study, rehearsal, and introspection, get into their roles' (Crafton 2013: 45). Although a physical actor is not "filling" the costume with their physical body in animation, the animator creating the character performance substitutes for the actor. There can be multiple "actors" in animation, for example, the voice actor and the animators who perform as "actors". As Crafton points out, the character costumes are designed parallel to character creation; therefore, the character costume is also part of the act of embodiment and altogether integral to the character creation in the animated character design process.

The multiple ways that costume design for animated characters links to the concept of embodiment is visible in the character design process, through the inclusion of costume to express characters' physical form. The animators create the character's body form through the design of the costume. Therefore, the character's body depicts the costume, and vice versa, the costume generates the body of the animated character. The costume also reacts to the character's movement and behaviour, depending on the costume material's weight and texture. This helps the animators embody their characters and convey a stronger impact of the character's physical and psychological self. These remarks reflect my analysis in this thesis; the costume designers' and art directors' interviews all indicated that costume design for animated characters also includes the act of embodiment. Thus, the concept of embodiment pertains to the discussion on the collaborative character costume design process. Each person involved in the character design, including the costume designer, thoroughly embodies the character, signifying their full understanding of the character's personality and physicality. In computer-animated films, each digital character's movements and experiences were also conveyed through costume design. I discuss this concept of embodiment in correlation to the collaborative design process in Chapter 3 and the motion study process in animation in Chapter 5.

Theories on materiality

In the frame of this research, materiality refers to tangible and digital materials. It became evident in the interviews that tangible material exploration comprised part of the costume designers' work process. In addition, the final digital animation process involved physical material exploration, and these both engaged with somatic, aesthetic, and embodied experiences. The literature also suggested that physical material properties are connected to animation, especially through examination of different material qualities and

their behaviour in real life. When I discuss "tangible materials" in this study, I mainly refer to garments, fabrics, and other physical material samples employed as part of costume design development and as a reference for the computer animation process.

In particular, I am drawn to the association between tangible and digital materials and the inclusion of tangible materials in digital character costume design, despite their strongly virtual production. Costumes are typically perceived as three-dimensional material objects, and the materials they include play a significant role. It is critical with physical costumes to touch, move, and feel them in order to understand the texture, weight, and feeling of the costume on one's hands and on a body when worn because costumes transfer a diverse range of sensory experiences (Pantouvaki 2019).[22] In addition, materials link to perception as textures convey different ideals, for example, shiny silk insinuates a more expensive clothing than raw linen material. Perceiving a soft texture of wool defines the garment as a wool garment, or shiny draped sateen implies a silk material.

To reflect more on material texture qualities in this thesis, I refer to Tim Ingold's (2017: 100) broadening of the concept of sensory perception to further include material textures. He notes that the material composition perceived through vision is dependent on the textures of the object's surface, in which the texture defines the object. The observation of the object through its texture is what Ingold refers to as haptic vision, a similar concept to Marks' (2002) haptic perception. Ingold states that haptic vision 'abides with surfaces, and dwells in them' (2017: 102). He links haptic vision to psychologist James Gibson's idea that all surfaces have a distinctive texture, which depends on the object's composition. In recognising texture, we can discern the composition of the perceived object (Gibson 1979, cited in Ingold 2017: 102). Through Ingold's ideas, tangible materials are identified through their specific textual qualities. Following Ingold's idea of haptic vision and its relationship with textures, I am interested in how this relates to materiality and the representation of tangible materials in digital costumes worn by computer-animated characters. Analysis of my interviews revealed that real, tangible materials, especially their texture qualities, are copied and reproduced in digital form in computer-animated films. This led to identifying material texture as one of the foci in this thesis. Ingold uses the term "object" in relation to textures defining the object, and in this research, the "object" refers to tangible material references and garments.

An interesting feature is the reproduction of real-world materials as digital materials. I consider Ingold's idea of real-world material properties perceived though their texture links with Jane Harris's (2013: 245) remark on digital materials, in which the general perception of digital 'material characteristics and properties is informed initially by their surface.' Haptic vision, therefore, defines both digital and real-world objects similarly by their surface textures. I believe that if the textured surface defines the perceived object, great importance lies in the execution and achievement of the digital surface of the character costume, its digital texture. The digital surface relies on referencing and reproduction from the real-world examples to create the surface texture understood by the audience. Therefore, the creation of the digital surface and the textures of the textiles depicted by the animated garments all require real-world references. Ingold's remarks resonate in terms of the tangibility of the material substance and Harris's comments on digital materials. In this thesis, these two ideas are connected through the discussion of materiality and the examination of the materials and their texture composition in digital character costume design. In addition, perceiving digital materials transfers multisensorial feelings to the spectator. Despite their digital production, the case study films invite a certain kind of embodied spectatorship that is transferred through the multisensory experience of viewing the digitally animated costumes.

In sum, this section has explored the theories and key concepts that I have chosen to include in my research, formulated from the findings of the data analysis. One of the main themes stemming from the analysis of the costume designers' oral testimonies and visual analysis is digital costume design's connection with multisensorial qualities of perception and the importance of tangible material exploration that transfers somatic feelings on the body. Both these themes are connected to the work of the designers and technical professionals who develop and create the costumes digitally, as well as the spectators who perceive the character costumes in the computer-animated film. Therefore, I chose the theory of somaesthetics, from Richard Shusterman, and the concept of sensory perception as the overarching concept for this thesis.

[22] Pantouvaki's (2019) study is another example that engages oral records as part of the research data collection method for costume research. Another similarity of my work with Pantouvaki's study is that we both make comparative cross-examination of costume designs and other design-related sketches with oral records.

My research specifically focuses on the development of costume designs within computer-animated films, in which somaesthetics is particularly pertinent as Shusterman (2012: x) argues that any art creation involves using bodily senses and experiences and that our lives therefore are lived somatically. I especially found the integration of bodily senses in design development engaging and explored this aspect in my research in the context of computer-animated characters that 'wear' a costume. Shusterman (2008:19) also notes that the definition of somaesthetics is a study focusing on one's experiences while appreciating the use of one's body as part of the sensory-aesthetic experience. Therefore, somaesthetics provides an appropriate framework for my study as I explore costume designers' experiences working on computer-animated films. Additionally, somaesthetics joins concepts such as aesthetics, embodiment, and sensory perception, pertaining to a significant part of my thesis findings.

Sensory perception is a concept that explores the multisensorial quality of perception, meaning that simply looking can transfer tactile and embodied feelings. It connects with my thesis topic, examining the presence of the multisensory quality of perception in the design development and production of digitally animated costumes. I also employ the concept of sensory perception to analyse the final outcome of the digital characters' costumes from an informed viewer's perspective. The embodied feelings that perception transfers are connected to the concept of embodiment. In my work, embodiment specifically refers to the design development and performance of an animated character. Multiple actors, animators, and designers make the character's identity and motion tangible through the costume worn by the digital character. In addition, embodiment is part of the spectator's empathic reactions that emerge from perceiving the character's performance. Embodiment also stems from the spectator's imagination and their own experiences of wearing clothes. I propose that in computer-animated films, the digital character's movements and experiences are conveyed through costume design. I also suggest that materiality connects with embodiment, as material qualities transfer different feelings to the body. By the concept of materiality, I refer to tangible materials, mainly fabrics used in making garments. I also refer to digital materials, meaning the digital reproduction of the tangible example in the real world.

To conclude, these methods and theories enable me to study the key characteristics of digital character costume design in computer-animated films, which I explore in the following chapters. The oral testimonies bring vital insights into the costume designers' experiences working on the case study films and shed light on their tacit knowledge. The cross-examination of the different visual and audio-visual materials, such as costume drawings, fabric samples, and the case study films, illuminate the different costume design development processes and the creation and outcome of digitally animated costumes. The theoretical concepts explored are presented with the three main themes – collaboration, technology, and materiality – in Chapters 3, 4, and 5. In the next chapter, I discuss costume designers' experiences and processes while working in the collaborative team of animated-film productions. This topic ties to the concepts of sensory perception and embodiment and discusses the findings in relation to literature. Following this, Chapter 4 concentrates on technology and the effect of the medium of computer animation on costume design development and the final outcome of the digitally animated costume. In addition to presenting my findings from the data, I explore the literature, in particular, technical papers published by the animation industry, and I also include the concept of sensory perception in the discussion. Last, Chapter 5 focuses on the industrial and visual relationship between tangible and digital materials in the case study films. Examples from each case study film are mentioned throughout the chapters to illustrate how costumes are developed and created across different animation studios and genres.

CHAPTER 3

CHAPTER 3

COSTUME DESIGNERS AS PART OF COLLABORATIVE COMPUTER-ANIMATED FILM PRODUCTIONS

This chapter focuses on the costume designer's fundamental involvement in collaborative animated filmmaking practice. Researching collaboration between costume designers and animators offers a rich starting point to delve into the various processes within computer-animated film productions that include the work of a costume designer. This chapter shares insights into the role of the costume designer as an important collaborator in character development, and the kinds of labour involved in the collaborative process of digital character costume design. It is important to give a voice to the designers to reveal the different workflows in which they are involved and with whom they collaborate, particularly as costume designers have not traditionally been part of animated film production.

All forms of animation, including hand-drawn, cut-out, puppet, and digital, require input from several artists and animators to succeed, even in the shortest animated cartoon. Heather L. Holian (2013: para. 11) remarks that the making of an animated film is a '"[t]rue creative collaboration,"... that involves a group of individuals who all interact with one another to collectively produce a single, final work ... They each make creative, conceptual contributions while responding to and engaging with the ideas of others.' Similar collaborative design development processes are visible within pop-

ular Hollywood computer-animated film productions. Computer-animated productions require thorough planning and supervision because the making of those films 'takes place in environments where most of the tools and processes are computer based' (Kerlow 2004: 48). These productions, therefore, require a number of professionals working with the technical software, making the processes 'team efforts where collaboration is a key ingredient for success' (Kerlow 2004: 48). There exist many spheres of labour in animation, for example, concept artists work towards the art direction, and technical directors oversee the visual effects animation that is computer-generated by numerous professionals. In addition, character designers and animators create and bring to life the characters. Each of these professionals' work connects with the others, with the shared goal of achieving the vision of the animated film.

Within computer-animated film productions, digital character development, of which costume design is a part, consists of an interdisciplinary collaboration between several professionals lasting throughout the duration of the film's production (Solomon 2013: 15). *Frozen*'s producer Peter Del Vecho notes that 'storytelling is pretty much the same regardless of the medium, but the amount of multidiscipline collaboration needed on a CG movie is greater. There are more people involved in each decision because we have people dealing with hair and cloth and lighting' (Solomon 2013: 15). Vecho implies that specifically in computer-animated films, creating hair on a character, animating hair movement, and adding light and shadow to hair, for example, are all tasks that involve input from more professionals than typical in other animated films. Professionals who work in character animation, creating cloth movement and texture surface, as well as lighting (light and shadow) are also involved in executing the final designs of a computer-animated character's costume. However, prior to these stages of computer-animated film production, the character costume design development takes place and involves the collaboration of several professionals on the production team.

Costume designers' contribution in collaborative computer-animated filmmaking is discussed by Kutt et al. (2018), who briefly mention the collaborative design development and digital creation of characters' costumes in the making of *Incredibles 2*. This film involved 'collaborative workflow and greater trust between people and departments,' which interestingly included skills necessary to make physical clothing (Kutt et al. 2018). Similarly in *Shrek,* the first CG animated Hollywood production to engage a costume designer, the costumes in the film had to function realistically alongside character movement, depict convincing material qualities, and react to human movement the same way as clothing in real life. Such specific qualities in animation require a special understanding of pattern, structure, and materials of "real" physical garments, as they represent the personal and physical qualities of the character in their costumes. *Shrek*'s art director Guillaume Aretos (2017) emphasises in his interview the importance of a costume designer's contribution towards this knowledge. Just as with producer Aron Warner, Aretos saw the value of employing Mussenden in the production of *Shrek*. On the importance of hiring a costume designer, Aretos remarked that 'you need their knowledge to really go into, how do you cut the fabric, how do you sew it, how strong is the fabric, how does it react, how does it flow, what's the weight of it, what's the appearance of it.' These physical qualities were transferred 'to surfacing and movement simulation,' garment qualities that are computer animated. It is therefore essential to understand how real garments and different materials function and what these elements convey, not only for character animation but also for visual storytelling purposes. These details are part of the costume designer's expertise and are naturally essential to costume design and costume making in live-action filming and live performance. Therefore, the costume designer is a vital collaborator in the multidisciplinary team of computer-animated filmmaking.

The collaborative work process in animation includes the work of several professionals, about which Holian (2013) emphasises the importance of each artist's contribution towards a feature-length animated film. Holian (2013: para. 7) argues that the animation studio 'provides clear evidence for dependence upon strong, *individual* artistic personalities embedded within a collective artistic unit' who should not be neglected, but instead, better understood and respected. This chapter responds to this remark and shows the collaboration of individual artists, specifically the costume designer, within the animation production team in contemporary computer-animated films. As indicated in the literature review, little is known of costume designers' work processes and contributions within computer-animated film productions simply because few designers have been engaged in animated film. This chapter shares important insights into the crucial contributions of a costume designer, particularly during the character costume design process. I focus on the labour involved in collaboration during character devel-

opment, which often entails hidden, tacit knowledge regarding the nature and process of collaboration. I discuss the stages of the process in which costume designers participate in the production, whom the costume designer collaborates with, and the elements that become part of the costume design process during the collaboration. The data I have drawn from the costume designers' interviews bring important insights into their professional experience and especially their input in computer-animated filmmaking. The costume designers interviewed for this thesis all agree that the final digital costume design resulted from collaborative design development. More specifically, Danny Flynn (2017) notes that costume development and the decisions on the final costume design in *Big Hero 6* 'was a group situation.' Ruth Myers (2017) continues that costume design in *Monster House* was 'a question of negotiation,' and Isis Mussenden (2018a) agrees that 'we do collaborate because it's important' and 'if anybody ever believed that those changes aren't made by more than one person they're lying [laughs].' The designers' mutual experiences and emotional emphasis demonstrate that the final digital character costume design results from the teamwork between the costume designer and several members of the film production. Describing this collaboration process is the focus of this chapter.

This chapter first discusses how the story is developed in the case study film productions, the ways this affects costume design development, as well as how costume designers are a valuable part of this creative process by visually connecting characters with the narrative. Thereafter, I expose how visual materials contribute to the collaboration between costume designer and production team, primarily the director(s), producer(s), production designer, and art director. This section introduces the theoretical concept of somaesthetics by discussing how experimentation with visual materials includes aesthetic aspects that are partly guided by the designer's (and other viewers') somatic perception. Last, I discuss the absence of the actor in the costume design process that occurs in creating an animated character. This is discussed specifically in contrast with live-action filmmaking and live performance, where actors often support costume design development with their own ideas on the character. In animation, the character's performance is created by animators and voice artists instead of the actor. Hence, this section illustrates the power of costume design in presenting the animated character's performance and the contributions of the costume designers to the collaborative development of the performance.

3.1 Story development and costume design

In computer-animated feature film productions, professionals in several departments work simultaneously, such that art direction, the character's visual appearance, script, and scenes are all developed at the same time. My focus in this section is on story development and the roles costume designers play on the collaborative team in developing the computer-animated film's story and characters. Film production schedules are a way to visualise the overlapping phases within the production (see Winder and Dowlatabadi 2011; Webster 2005; Musburger 2018). Winder and Dowlatabadi's (2001: 109, 2011: 121) example of a CG feature film production schedule (Figure 4) clearly illustrates these simultaneous work processes. According to Winder and Dowlatabadi (2001: 167), characters in a computer-animated film are first developed by the visual development artist during the "visual development" phase. Thereafter, the character designs are refined by the character designers and then finalised by the lead animators. In addition, sculptors work on maquettes, which are three-dimensional physical models of the characters' bodies that assist animators to draw and move characters in their digital form. This thus demonstrates the number of artists who collaborate in developing a character's final look and performance. The costume designers' interviews indicate that their work occurs during the "visual development" phase, and they agreed that the art direction and film script were developed parallel to their work. These particular work phases are indicated in the production schedule example, by "visual development" taking place at the same time as "art direction" and "storyboard". Costume designers' work in the case study films lasted until the "animation" phase when the character's visual appearance and acting are created. For this reason, if changes are made to the costume during the digital character animation or "character finaling" stage, costume designers are no longer involved in costume-related decisions.[23] According to Mussenden and Aretos, the production designer oversees costume design development after designers have left the production (Mussenden 2016b, Aretos 2017). However, no literature sources indicate this stage of the costume design process.

[23] The impact of costume designers' "dis-engagement" in the films is further explored in Chapter 4.

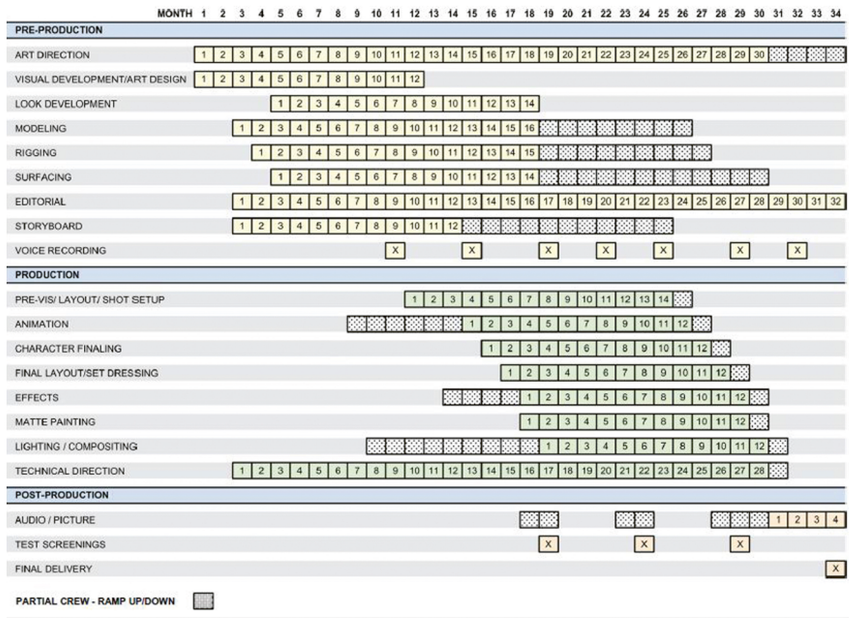


Figure 4. Computer-animated feature film production schedule example by Winder and Dowlatabadi (2011) that illustrates the overlapping production phases. Winder and Dowlatabadi (2011: 121).

The costume designers' work process is influenced by the labour taking place simultaneously across different film departments. Mussenden, Segal, and Flynn experienced that script development specifically influenced their costume design process. Costume development is performed collaboratively as part of the visual development; the characters and the action and locations in the scenes are naturally important for the costume designers. Scenes in the film are typically reworked and evolve until the very last phases of the production. Such adaptations to the scenes can include issues related to dramatic moods or change of action in a scene, which are all reflected in the costumes. In addition, removing or adding characters in the film also impacts the costume designer's work.

In order to revise and develop the film's narrative, large animation studios such as Disney and DreamWorks have employed a particular method of using a story treatment (instead of a detailed film script) during a film's pre-production phase (Wright 2013: 276).[24] The story treatment informs general aspects about the characters (age, gender, status), the main ideas of the film's narrative, and the dramatical ways the story is told to the audience (Selby 2013). For costume design development, the treatment provides information regarding the character's personalities; thus, this can vary in scope and depth depending on the production in question (Silver 2017). The treatment is shared with the scriptwriters for further story development and with those who work on the visual look of the environments and characters (Wright 2013: 276). Costume designers Mussenden, Segal, and Flynn each reported receiving a story treatment at the start of their work on the computer-animated films. Mussenden (2018a) specifically points out that 'we get the treatment because they're developing the film scene by scene and the story.' The designers' statements verify that they receive the treatment just like the other team members working towards the visual look of the film.

The story treatments are used in animation to develop the scenes throughout film productions. The treatment in animation, however, differs from the ways costume designers traditionally work in live-action films. Mussenden (2018a) recalls that animation treatments were less informative compared to film scripts in communicating aspects regarding the action, mood, and characters in different scenes. Mussenden's view derives from her previous experience in live-action films, in which costume designers are offered a film script presenting more detailed information on the scenes and characters in the film. Similarly, Segal (2017a) explains that when costume designers enter live-action film productions, the script is already mostly approved, and changes in the narrative are minor. The script provides a foundation for their work, to which they can return during their costume design development. In an interview with Nadoolman Landis (2003), film costume designers James Acheson, Ruth Carter, and Eiko Ishioka each express the importance of familiarising themselves with a script prior to the costume design development, as it details the characters and locations of each film. The script also functions as a tool in discussion with the director about costume design (Nadoolman Landis 2003: 14, 38, 48). Thus, computer-animated films offer costume designers fewer clues regarding the film's characters, the narrative, and specific scenes as do the film scripts of live-action films. These

[24] In hand-drawn animated film productions, the film's story is similarly developed throughout the production.

film scripts provide useful details regarding locations, mood of the character in particular scenes, and whether scenes involve interior or exterior shots.

In contrast to the other case study films, Ruth Myers' experience working on *Monster House* differed from that of the other designers. *Monster House* is a comedy-horror film about three children entering a haunted house on Halloween. The film did include a detailed script rather than a treatment because the production included motion capture (mocap) filming. Mocap filming 'is the technology that enables the process of translating a live performance into a digital performance' (Menache 2011: 1). The actor's physical performance is tracked in filming by adding small tracking sensors to various parts of the actor's bodies. These filmed performances are merged with computer-generated animation via specific software (Rinzler 2006: 15).[25] In motion capture, the authorship of performance, however, is tied to the actors' input and not the digital creation presented on screen (Mihailova 2016). As the animation in *Monster House* was first mocap filmed and computer-generated afterwards, a detailed script was needed to prepare the acting in the specific scenes for mocap filming. For this reason, Myers had the advantage of examining a full film script and was able to gain important details about the film's narrative, such as specific scenes, as well as the characters – more than the costume designers working with treatments in the other case study films. Furthermore, there were no changes made to the *Monster House* script and no characters added or removed during her costume design development. Thus, Myers' experience clearly differed from the other designers in the other case study films. Myers' remark 'as always, I started with the script and had talks with the director' (Rinzler 2006: 24) supports the fact that during the production of *Monster House*, she started her costume design development in the same fashion as in live-action films.

The continuous scriptwriting process in computer animation (excluding *Monster House*) and overlapping sections in the production do offer a possibility for collaboration with the costume designer in the story development. Costume designers Mussenden, Segal, and Flynn noted that the constant script development and overlapping phases in the production flow influenced the costume design development and the costume designer's work. For example, while working on *Shrek the Third*, Segal reported that during his costume design development for the lead character Guinevere, the importance of the character changed when some of the scenes were revised: the character became one of the generic characters[26] in the crowd scenes. Consequently, in this case, the character costume design also changed as the role changed in relation to the scene and in relation to the other characters. I explain this case in more detail in Section 4.4 as part of the discussion on generic character costume design development.

The production of *Shrek the Third* offers one example of the animation script development, in which Segal believes his knowledge in costume design was valued and taken into consideration in generating comedic ideas for the scenes through costume design-related ideas. *Shrek the Third* continues the story of Shrek, his wife Fiona, and their friends Donkey and Puss in Boots. In this third film of the franchise, Shrek and Fiona are set to succeed her dying father, King Harold; however, Shrek fails to serve as the regent. Unlike the previous two *Shrek* films,[27] some scenes in *Shrek the Third* were not set specifically in any historical era. This decision derived from the director and scriptwriters. Therefore, Segal collected ideas for the character costume design, which combined historical references from different periods (Segal 2017a).

Segal recalls collaborating with director Chris Miller and having discussions about using historical garments from different periods in the film, for comedy purposes, for example, in the scene where Shrek and Fiona are presented to the court as regents (Segal 2017a). The scene involves Shrek and Fiona arriving at the court banquet, where Shrek is displayed as out of his typical environment as an ogre living in a swamp. Shrek's costume ensemble in Segal's drawing consists of features from early 16th century men's attire, which emphasises his large upper body (Figure 5). The design of his high-heeled shoes is from a later period, from early 17th century, but is a deliberate addition to create comedy in his appearance and performance, as they are extremely unpractical when he tries to walk. Segal (2017) also recalls sharing an idea about Shrek and Fiona wearing tall white-powdered, glittery wigs,

[25] For full definition of motion capture and its characteristics, see Pizzo 2016 or Menache 2011.

[26] Lead characters are the principal characters that have an important role in the storytelling. Supporting characters have less significant roles and thus have less dialogue with other characters. Generic characters, also called "extras" in the crowd scenes, have either minor or no dialogue and visually represent the division between generics and lead characters. See more in Chapter 4, section 4.4.

[27] *Shrek* and *Shrek 2* depicted a stylised version of the height of the Middle Ages, around 14th century, visible in the film's environments and character costumes. I explain this further in the Section 3.2, 'Art direction and concept art, the starting point for costume design.'

visible in Segal's costume drawing for Shrek. The style of these wigs, popular in the mid-18th century, is humorous when worn by Shrek and Fiona, especially since Shrek's traditional habitat and attire are quite different. Therefore, these stiff, impractical court costumes made of silk, ruffles, and ribbons are a strong contrast to his everyday clothing of a dirty white linen tunic and plaid hose. In this scene, his entire costume ensemble emphasises this element of incongruity and adds further comedy to Shrek's transformation from ogre to regent.

Figure 5. Israel Segal's costume design suggestion for Shrek in a scene where he and Fiona are presented to the court as regents. His costume ensemble consists of features from different period fashions to enhance comedic appearance and performance. Courtesy of Israel Segal.

Figure 6. Israel Segal's costume design suggestion for Fiona and Shrek in a scene where they are presented to the court as regents. The visual reference for Fiona's dress originates from Velázquez's portrait of Mariana of Austria. Courtesy of Israel Segal.

Figure 7. This image illustrates Fiona's costume in the film, which includes a millstone collar and a white wig, similar to those depicted in Shrek's costume drawing. These have been added to create a more comic physical and visual appearance. Screenshot (cropped) from *Shrek the Third*.

In the same court scene, Segal presented a stiff dress with an exaggerated silhouette as one of Princess Fiona's costume ideas. Its design resembled a 17th century Spanish court dress, inspired by the Spanish court dress of Mariana of Austria, featured in Velázquez's painting of 1652–53. The particular shape of this type of dress forces the wearer to walk slowly, and the stiffness restricts any bending or turning (Figure 6). The costume designer's idea for the style of this costume facilitated ideas for comedic dialogue and action in the scene dictated by these wardrobe restrictions. Another example

that Segal suggested for both characters in the same scene is the millstone collar, depicted in Shrek's costume drawing (Figure 5) and visible on Fiona in the final animated film (Figure 7). The collars generated a comedic idea for a particular moment in the scene when Fiona and Shrek try to kiss but cannot reach each other due to the wide ruffs. These examples demonstrate that different costume choices can add comedic elements to the scenes and ideas for the later animation performance. However, in the development of a CG animated film, these ideas are not typically generated collaboratively with the costume designer.[28]

Further similar ideas proposing comic elements for scriptwriting through costume in *Shrek the Third* are evident in Segal's costume design ideas for the cheerleader characters first introduced in a scene welcoming Shrek, Donkey, and Puss to a high school. In this scene, the location and backgrounds of the high school appear reminiscent of medieval castle grounds. For this reason, Segal reflected on late medieval references in order to enforce a more thorough visual connection with the time period depicted in these backgrounds. Segal combined common cheerleader equipment such as pom-poms and megaphones with elements stemming from the height of the Middle Ages, circa 14th century. As one option, he suggested replacing the cheerleader's pom-poms with morning stars (Morgenstern), a weapon commonly used in Germany in the 14th century (Figure 8). However, this design idea was not used in the film. Instead, Segal's other proposal of using hay as the pom-pom material was chosen for the cheerleaders (Figure 9). The texture and sound of hay while in movement connected well with the materials that pom-poms are commonly made from. Although the idea of using morning stars as pom-poms was not included in the film, it shows how costume designers' ideas for costumes can be used to connect to a particular time period and develop action in a scene. Segal's suggestion for using hay material generates ideas that relate to movement, which is a part of animating character movement that is commonly executed in computer-animated feature productions without a costume designer's presence.

Another costume design–related idea connected specifically with character animation and scene development again stemmed from Segal when he provided inspiration for the cheerleader characters' performance. This design idea emerged from the cheerleaders' megaphones that they sometimes use as part of their performance choreography, as well as from the similarity of a megaphone's shape to a late-medieval conical headdress. The late-medieval period connects with the design style of the backgrounds in the scene. Segal proposed that the cheerleaders wear this conical headdress and then take it off during the dance performance to use as a megaphone (Figure 10). This performative idea was eventually not used in the animated film, but the conical headdress design was included in the cheerleader's costume ensemble (Figure 11). The design operated as a link between the characters and the backgrounds in this particular scene, making the medieval time period especially apparent. Although not all of Segal's performative ideas were included in the characters' performance, these examples demon-

[28] I explore this topic further in Section 3.4.

Figures 8 (left) and 9 (right). Two of Israel Segal's costume design ideas for the cheerleader characters in *Shrek the Third*. The visual inspiration of the height of the Middle Ages was used as a comedic, performative element in the scene. Visible in Figure 8 is the idea of using medieval morning star weapons as pom-poms, which did not end up in the film. Figure 9 shows the hay material as pom-poms, as well as a slightly different cheerleader costume. Courtesy of Israel Segal.

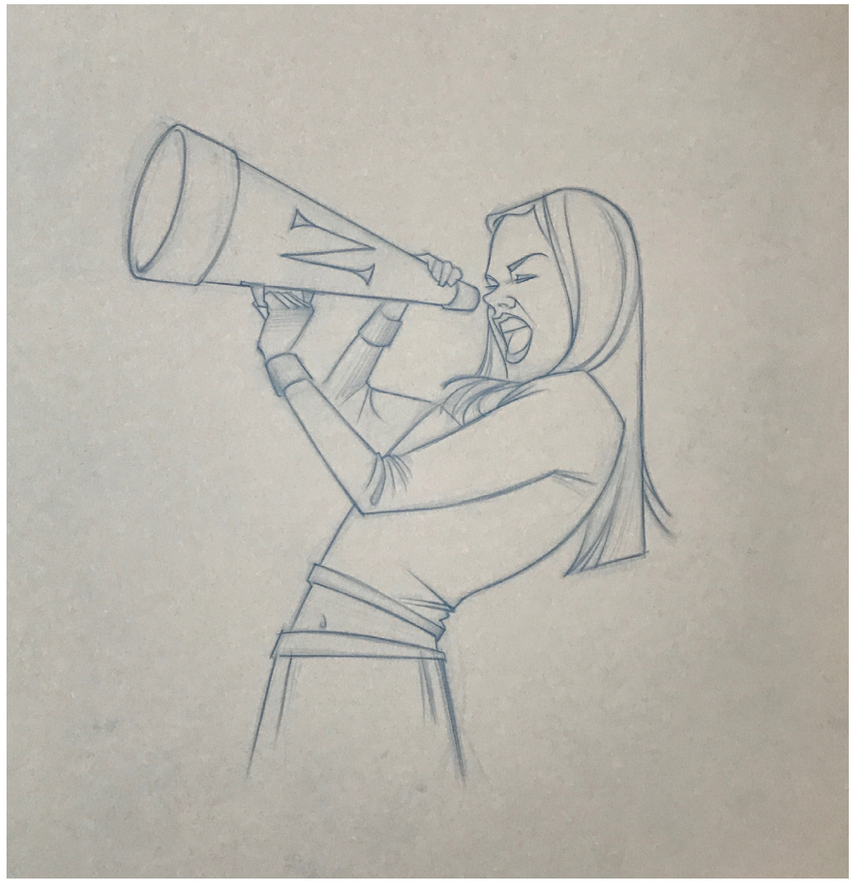


Figure 10. Israel Segal's costume drawings suggest how the cheerleader's medieval steeple headdress could function as a megaphone. Courtesy of Israel Segal.
Figure 11. The style of the conical headdresses was included in the final animation. Screenshot (cropped) from *Shrek the Third*.

strate that the costume designer's ideas can contribute to both costume and performative elements in the story development.

As the animation production process involves simultaneous script and character development, the costume designers can clearly participate in these processes and share costume design–related ideas for action in the scenes, as the previous examples from *Shrek the Third* shows. Segal's experiences with the scriptwriting in *Shrek the Third* prove that the scriptwriting process benefitted from a costume designer's input. The costume designer's presence and creative contribution enhanced the discovery of costume elements and its implementation in writing the comedy and performance in the film's scenes. In fact, concepts for entire scenes were actually facilitated by Segal's costume design–related ideas. In addition, a costume designer's involvement in scriptwriting consequently affects the time spent on exploring costume ideas, which positively shortens the production time and therefore reduces the film's budget.

To conclude, this section discussed how computer-animated film stories, in particular the *Shrek* franchise and in *Big Hero 6*, are developed throughout the production, simultaneously with the character development phase when costumes are also designed. Computer-animated films employ story treatments to develop the narrative, characters, and action in scenes, indicating that these elements are not yet finalised at the start of a costume designer's work in the film. In the costume designer's initial work process, treatments offer only general ideas of the character's personalities, such as age and gender, and the overall ideas of the scenes in the narrative. The characters' more profound characteristics of their personalities are developed throughout the production as part of character development, simultaneously with costume design. Scenes are also developed during the course of the film productions, and this mode of filmmaking offers a place for costume designers to collaborate not only for character development but also by generating ideas for the narrative through their expertise in costume design.[29] However, this scenario remains uncommon. In the case study films, only Segal's experience in the making of *Shrek the Third* showed a costume designer as an inspirational collaborator in the script development, bringing ideas to action in scenes via costumes. This rare example reveals the worthwhile contribution of a cos-

[29] Because hand-drawn animations adopt similar scene and script development processes as computer animations, I argue that costume designers can collaborate in finding ideas for narrative and specific scenes through costume.

tume designer to the collaborative script development team. The costume designer successfully proposes costume ideas that become important visual indicators for narrative development and enhance the characters' connection with the action in the scenes.

3.2 Visual materials as part of collaboration

Visual materials, such as concept art, mood boards, storyboards, and costume drawings convey additional information not included in the written treatment commonly used in animated film productions.[30] These function as additional support for costume designers during the costume design development process and enrich the information that is lacking from the written film treatments. They are materials that enhance the understanding of the production process when several parts of the production are developed simultaneously. The costume designers' interviews revealed that use of visual materials was a major part of their costume design development for digital characters. These materials functioned as a tool in the collaboration and shared information across the different professionals, including the costume designers, director, producers, production designer, scriptwriters, and so on. Although the visual materials employed in the designers' work sometimes differed across the case study films, each of the materials performed in their own way as a visual tool in collaboration.

Art direction and concept art: the starting point for costume design

The visual style of the film is defined by the term "art direction", and creative goals towards this are set collectively by the production designer, who works in collaboration with concept artists, the art director, and director (Kerlow 2004: 47). From the early stages of a new animated film, the production designer and art director serve on the visual development team[31] that explores, in collaboration, different kinds of visual ideas as the film's aesthetic design that eventually forms the film's art direction. The art direction depicts the animated film's concepts visually, portraying the style of the backgrounds and characters, as well as colour and 'design language' (Bacher 2013). In more practical ways, art direction is a phase early on in a production and any changes in the visual look of the film would cause delays and additional expenses to a production (Kerlow 2004: 47). The visual aesthetic design that is set in the art direction has a strong influence on costume design. As in animation, each professional working towards the film's visual style grounds their work in the visual references generated by the art direction.

Often several concept artists work towards finding the correct style of each film through hundreds of concept art renderings. Concept art is used to create 'the appearance of the characters and their relationships, the action's locale, a sequence's mood and color, costume and set designs' (Canemaker, 1996: ix).[32] Animator Stephen Silver (2017) adds that visual aesthetic style determines, for example, whether the aim is to visually create a more exaggerated cartoon world or a more realistic design. The production designer and art director use the visual material of concept art as a visual tool in collaborative discussions with costume designers. Costume designers take inspiration from concept art in order to link the costumes with the rest of the visual look in the film. Thereafter, they explore and employ the visual information from concept art in their costume design development. The following examples demonstrate how concept art plays an important role in the costume designers' work process and the elements that inspire and inform costume designers' development of digital characters' costumes.

The costume designer interviews indicated that collaboration between the costume designer, production designer, art director, and director occurs at the start of the costume design process in the case study films. The director, production designer, and art director examine the concept art renderings of a film in the important collaborative discussions with the costume designer (Mussenden 2016a, 2018c; Segal 2017a; Flynn 2017). For example, during the production of *Shrek the Third*, Segal found that observation of the

[30] Costume designers also employ other kinds of visual materials in their costume design development, such as images in books and journals or photographs taken from paintings and sculptures in museums. As these visual materials are mainly used for the purpose of their personal work and not as part of collaborative design development, they are left out of the discussion in this chapter. I discuss the use of these particular visual materials in Chapter 5, section 5.1 'Tangible and visual materials as part of costume design development.'

[31] Concept artists who created the conceptual designs execute an extensive amount of research towards these designs. See Canemaker 1996: ix.

[32] In early hand-drawn animations, these artists were the predecessors of the actual profession of concept artist working today in live-action film industry.

film's concept art renderings enhanced his ability to understand the film's aesthetic design and story development. Furthermore, the concept art crafted by production designer Aretos assisted the collaborative discussions on the visual representation of characters in relation to the film's narrative. The discussion with Aretos became the grounding for Segal's costume design development, and he remarks that '[Aretos] was the driving force behind my designs as he had a very singular vision' (Segal 2018).

Similar to Segal, Mussenden (2018c) found Aretos' concept art and his art direction useful in her costume design development. For example, during the production of *Puss in Boots*, conceptual designs offered visual information for the environments and characters. The film is a spin-off from the *Shrek* franchise, where Puss and his friends Humpty Dumpty and Kitty Softpaws aim to obtain the magic beans that lead to fortune from the two outlaws Jack and Jill. The film is set in the Renaissance period in the Spanish region. The art direction of this film was shared with the costume designer Mussenden in each production meeting where Aretos offered her new concept art renderings from environments in newly developed scenes, helping her place the characters in a particular frame. Mussenden (2018c) points out that 'it is always helpful to see the locations and the environments so that I can keep in sync with the overall design of the film.' For example, Aretos' concept art for *Puss in Boots* (Figure 12) displays the visual style of the environments that inspired Mussenden in her costume designs. The ideas for this particular visual style derived from the characters, who were twisted and backstabbing each other. Aretos (2017) explains the ways the word "twisted" merged into the visual stylisation by 'twisting everything, the architecture, the objects… if you look carefully the film, there is not one straight building… they're also all twisted.' This remark is visually evident in Aretos' concept art, in which all lines flow at angles, twisting and bending. Such ideas inspired Mussenden, and the particular aesthetic design continues in the costumes with soft round character silhouettes and a connection to the colour scheme.

Figure 12. Guillaume Aretos' concept art for the production of *Puss in Boots*. His design idea of visually twisting the form of locations and architecture is clearly visible in this concept art example. Image source: Guillaume Aretos' online portfolio www.aretos.com.

In the case study film *Monster House*, the art direction was similarly linked to the film's costume design as in *Shrek the Third* and *Puss in Boots*. The film's director Gil Kenan explains that concept art renderings defined and captured the visual aesthetics of each scene, which were also used in the film's costume design. The aim was not to accurately portray the colour or specific detail shown in the concept art, which was more 'about capturing feelings to create an emotional map of the film' (Rinzler 2006: 16). Concept art is visually informative of the film's environments and locations, which inspire the costume design. For example, *Monster House*'s concept art was instructive regarding the film's unspecified time period in the late 20th century. Furthermore, it revealed stylistic ideas for the location specifically set in a typical suburban neighbourhood in the USA. Figure 13 illustrates *Monster House*'s art direction and style of the locations and setting through concept artist Chris Appelhan's art.

In *Monster House*'s art direction, the colour choices in the locations morphed from realistic to stylised. The principal unrealistic design in the film

Figure 13. Examples of *Monster House*'s art direction by Chris Appelhan. Image source: Chris Appelhan's online portfolio www.froghatstudios.com.

was the house that was alive (Rinzler 2006: 21, 48). Producer Steve Starkey remarks that in addition to the visibly unrealistic design in the location setting, for example, the design of the house, the film's characters were also exaggerated to some extent from traditional human form and design. As the design of the characters and scenery slightly differed from real life, the costumes, on the contrary, followed realistic design (Rinzler 2006: 15). Hence, this demonstrates that concept art direction delivers a wide range of visual information that a costume designer employs in their work. In the examples of *Monster House* concept art, there are clear references related to time, such as placing the film in a contemporary era rather than a historical period. Similarly, the definition of colour range and aesthetic design ideas influenced the slightly exaggerated characters that matched with the setting. All of these aforementioned features from concept art facilitate ideas for character costume design.

Costume designers in computer-animated film productions evidently benefit from concept art, as they use the visual references for a better understanding of the locations where the characters are placed. Concept art informs everyone involved in the creative team about the film's visual language; therefore, it is valuable to share in the collaborative discussions with the costume designer. As concept art relates strongly to the narrative in terms of depicting the particular time period in which the film is set, it is particularly instructive for the costume designers to find references to better connect the costumes with the film's narrative.

In addition to the role of concept art in defining environments and locations, concept art also provides visual information about a film's time period. The definition of the specific era is critical not only for the visual coherence in the film but also to guide the costume designer to link the costumes seamlessly with the film's visual depiction of the time. As I pointed out earlier in Chapter 1, costumes are highly informative in providing a visual connection with a film's time period – to which concept art affords a starting point for researching visual inspiration for each characters' costumes. When all costumes follow the same period design, this coherent visual style also ties the costume design to the entire film, not only in one scene or for a few of the characters.

The production of *Shrek* aimed to present some realistic features from the time period of the Middle Ages; however, each such realistic feature was stylised according to the visual style defined in the film's art direction (Aretos 2017). *Shrek* is the first film of the comic fairy tale franchise depicting the adventures of the ogre Shrek and his friend Donkey. Animator and professor Tom Sito worked as a storyboard supervisor and storyboard artist during the pre-production of *Shrek* (Sito 2020a). He remarked that at first, there was some question of precisely which period of the Middle Ages in Europe the film was set. Producer Jeffrey Katzenberg initially expressed 1000AD, which was still in the Viking and Norman Era. However, that time period seemed too early for the elements of costumes and accessories being called for, for example, plate armour and armoured horses, which were used during 1260s and later. Consequently, in their visual research, concept artists referred to many of the book illustrations of Howard Pyle and NC Wyeth for the romantic novels of Ivanhoe. The time period focused on the height of the Middle Ages, circa 14th century and mostly to England (Sito 2017, 2020b). The decision of the exact time scale for the film greatly affected the design of the scenery as well as the costumes, as clothing styles differ throughout the long period of the Middle Ages. The exact time frame enables the costume designers to search for visual inspirations for costume designs, for example, from historical sources such as paintings and engravings that convey period-specific clothing. *Shrek 2* continued a similar aesthetic design and time period around the14th century that was presented earlier in *Shrek*.

In contrast to the historical costume design in the *Shrek* film franchise, the science-fiction computer-animated film *Big Hero 6* portrayed a more futuristic time period. *Big Hero 6* tells a story about robotics enthusiast Hiro and his adventures with his four friends and a healthcare robot named Baymax. This films' location was situated in an urban environment, in the city of San Fransokyo, combining the environmental design and atmosphere of San Francisco and Tokyo. The art direction aimed towards a combination of hi-tech and historical culture from both inspirational cities (Julius 2014: 14). The technology theme appeared in the film's narrative and was visually conveyed in locations; some scenes took place in the San Fransokyo Institute of Technology research lab. The Japanese influence was mostly inspirational in developing the futuristic design for the film's hybrid environments (Figure 14).

The design aesthetic that stemmed from visual traditions of Japanese hi-tech culture was unmistakable in the depiction of the superhero costumes worn by the lead characters in the latter part of the film. During the production of *Big Hero 6*, Danny Flynn recalls observing concept art displayed on the meeting room walls at Disney, which enhanced his costume design

Figure 14. The art director for environments, Scott Watanabe's concept art for the film *Big Hero 6*. Image source: Watanabe's online portfolio www.watanabeart.com.

development. Some displays were more informative for the character's visual appearance, such as the one by concept artist Ryan Lang (Figure 15), which portrays the characters in their superhero costumes. While observing concept art, Flynn sketched and made notes of the designs and then applied the visuals to assist his research and costume design (Flynn 2017). In his case, too, concept art was visually instructive and was used as a visual tool in the collaborative design meetings to share other designer's ideas across the film production departments.

In sum, art direction and concept art proved to be valuable visual indicators in costume designers' collaboration and costume design development, communicating ideas about the film's overall visual aesthetic design, locations, and time period. Concept art allowed costume designers to follow the film's visual aesthetic style and tie the costumes to it, including the film's backgrounds and specific scenes. The analysis in this section demonstrates that concept art functions as a visual tool in collaborative discussions related to the production's overall aesthetic style, conveying information related to the narrative. Costume designers rely on the art direction visualised in concept art as a starting point for their costume design development. When

Figure 15. Concept art by Ryan Lang for *Big Hero 6*. Image source: Ryan Lang's online portfolio www.ryan-langdraws.com.

costume design is strongly connected with the film's art direction, it enhances the coherent visual look of the film.

Texture information in mood boards

Mood boards are also an important element of the production of computer-animated films and an integral part of the film's visual development. Animators commonly assemble them as their personal references for character development, and art directors to display and share information regarding a range of visual development materials such as concept art renderings that serve to orient and inspire a film (Rall 2018). Where concept art provides ideas for the colour scheme, visual language, time periods, environments and locations, mood boards are equally informative but provide a collection of different visual references. They also include tangible three-dimensional textures, such as textiles and different texture qualities. The tactile information found in the mood boards broadens the visual inspirational materials from concept art, as 'it is important not to forget that knowledges are conveyed through all sorts of different media, including senses other than the visual' (Rose 2001: 10). Therefore, textures and tactile materials exemplify other explanatory media that communicate details of the film's visual world and broaden the understanding of the film's aesthetic design. For example, fabrics included in mood boards enhance the visualisation of different textures and enable the designers to explore the tactile quality of the materials. These textures facilitate the transfer of tactile dimensions in the film, which evokes spectators' haptic vision to sense the textures through sensorial experiences such as vision, similar to Marks' (2000) remarks on haptic vision.

The use of mood boards illustrates the inclusion of costume designers into the film's workflow across departments. In *Shrek*, *Shrek 2*, *Shrek the Third*, and *Puss in Boots*, Aretos worked on the films' visual aesthetics also by assembling mood boards, which were shared with costume designers Mussenden and Segal for use as another source of visual inspiration for the costume design. The mood boards included images, fabrics, and words that were connected, visually or textually, with each film's story (Aretos 2017). Mood boards function as another communicative visual material to enhance the multisensorial experience for costume design development, as experiencing the materials also through touch further assists the digital character's costume design development. This is especially important in computer animations in which the tangible material textures are reproduced as digital textures.

Mood boards are extremely informative for the costume designers in their design development by providing references that creatively enforce the textures for character clothing. Mussenden (2018b) recalls that in her costume design development, at the stage in which her work is inspired by concept art and mood boards, she is 'making it already,' indicating that at an early stage of costume design development, she considers the fabrics, textures, as well as 'thinking about how that [fabric] folds, I'm already thinking about the functionality of it,' meaning the costume construction. The texture references in mood boards enable the costume designer also to explore tangible textures in addition to the visual materials in the concept art and implement these as inspirational choices for the costume materials.

In computer-animated films, examining these texture qualities assists costume design development as the textures give further ideas for costume materials. Examining these tangible textures is connected to the perception of what we see via somaesthetics, as the tangible materials increase the experience from a purely visual perception (e.g., observing concept art) to a tactile dimension. Being able to touch the material references enhances the visual observation of the texture, which informs the designer, for example, about the thickness, smoothness, roughness, and sheen of the textures. Touch is felt in the body (soma), which creates different kinds of feelings in the designer's body. Each designer reflects on the tactile experiences in their own way and, for example, rough or smooth texture surface transfers feelings that stem from their personal past and experiences, which guides their choices for character costume designs. Shusterman (e.g., 1999, 2008, 2012) defines the body as the centre of sensory appreciation and creative self-fashioning, which also includes aesthetic qualities. Therefore, costume designers seek aesthetically suitable qualities for costume designs by exploring tactile materials (in the mood boards) through touch, creating different kinds of bodily feelings than solely observing visual information, for example, in concept art.

Storyboards informing story development

Storyboards are a common element of story development in film productions, exploited in contemporary computer animation, as well as in hand-drawn animated films and live-action filmmaking. The creation of storyboards develops and visualises a film's narrative and action in scenes (Pallant and Price 2015). In computer animation, a medium that requires careful production planning and where workflow is reliant on digital technology, 'the storyboard remains a central and valuable pre-production document' (Pallant and Price 2015: 154). Storyboards are created by storyboard artists, who narrate the story in visual terms, usually giving a general idea of the events in scenes (Wright 2013: 3). Storyboards are visually informative regarding the film's scenes, their angle and frame, whether the filming concentrates on close or distant shots, and work as a visual, two-dimensional adaptation of a film's narrative (Rinzler 2006: 16, 18). Sito (2020) notes that at Disney, Pixar, and DreamWorks, storyboard artists collaborate with screenwriters, during which each of them shares ideas in order to develop the story. Wright (2013: 3) also notes that storyboard artists work in groups. Storyboards are developed in meetings in which the story development team works on sequences to receive feedback for changes, especially from the director and producers who pass the final approval on the scenes. When storyboard artists collaborate with the director, producers, and screenwriters, the storyboard itself works as a visual tool in the communication between these professionals.

Based on the costume designers' interviews in the case study films, storyboards are also shared with each of the costume designers, working as another visual tool in collaboration with the other members in the computer-animated film productions. They recalled that storyboards were presented to them in the production meetings at the start of their design process, as well as during the later phase of the design development. The costume designers reported that storyboards enhanced their ability to understand

the narrative progression, which continually changed during the pre-production phase. In relation to costume design, storyboards visually inform whether the scenes require a costume change or a particular costume due to shot position (exterior or interior) or a change in weather or mood in a scene. Flynn (2017) specifically states regarding his design development for *Big Hero 6* that sometimes the information regarding the narrative was 'very vague,' and he found that storyboards helped him to better understand the constant changes in the film's narrative. The evolution of a story within the production of computer-animated films is visualised and better understood through storyboards, as well as with other visual materials such as concept art. Hence, during the production of *Shrek the Third*, Segal (2017a, 2017b, 2018) similarly observed storyboards in multiple meetings, and he also noted that 'the storyboards and the story were constantly evolving.' Storyboards were also presented to him to demonstrate the progress in the narrative and changes in the scenes. Segal found that these assisted his costume design development, as he could obtain a broader visualisation of the film. Segal's experience was also that storyboards were presented to the film's director and producers, which means that storyboards were visually informative in the collaboration between several professionals in the film's production.

In the case of *Monster House*, detailed storyboards were also created to visualise the film's narrative. However, for this film production, the script was already finalised prior to costume designer Ruth Myers' entry into the film's production. Similarly, the entire film was storyboarded. Myers (2017) notes that storyboards were shared with her at her first production meeting. She found that the visual information in the storyboards was beneficial for her costume design development as she could visually follow the changes in the narrative and visually perceive the entire film from start to finish. Myers' experience differed from that of the other designers, as in her case, the film's story did not change when she worked on the costume design development. For this reason, Myers was able to visually follow the changes in the film's narrative already at the start of her costume design development. Therefore, Myers gained significantly more information about the story of the film and its characters at the start of her costume design process than any of the other costume designers in the case study films.

The costume designers' experiences in the case study films demonstrate that storyboards were also part of the costume designer's work process, mainly functioning as a visual tool to understand the story development. This is partly connected with the fact that the film scripts are not entirely written, and the story is developed in parallel with costume design. For this reason, there exists a greater need for visual information to indicate the new film scenes, and storyboards assist in a more thorough understanding of these changes.

Costume drawings

The act of drawing is essential to the development of animated film productions, regardless of their medium – by hand or via digital tools. Drawing is visible in computer-animated film's pre-production phase in the making of concept art, character designs, or storyboards (Wells et al., 2009). Birgitta Hosea (2010: 356) notes that 'drawing in animation is used for more than the traditional illustration of a movement or the visual communication of a design, but is a vital, non-verbal part of the creative development process. Even if the final outcome is a technologically complex CGI animation.' This quote reveals that even within computer-animated film productions, a place can be found for elements of the hand-drawn, in which drawings convey the design ideas and character movement and function as a communication tool. Similarly, the costume designers in the case study films each created costume drawings to share their design ideas for the character costumes. This section focuses on the different ways costume drawings and the act of drawing function as collaborative visual tools in digital character costume design.

Costume designers produce costume drawings to visually explore different ideas for character costumes and to share them with others in collaborative teams. The terminology of costume drawing varies, sometimes referring to costume sketch, rendering, illustration, and in film productions as costume concept art.[33] I specifically use the term costume drawing, which refers to all quickly made sketches, more refined costume development drawing, and finalised costume design. Costume drawings also relate to the act of drawing, how drawings are used as a communicative tool to visualise costume designer's ideas, and the multiple visual aspects costume drawings convey. The act of drawing is inseparable from thinking, and costume draw-

[33] For more information regarding costume drawings, see Malinen (2017) *Drawing Costumes, Portraying Characters. Costume Sketches and Costume Concept Art in the Filmmaking Process.*

ings are interlinked with the ways that costume designers explore and present costume ideas (Malinen 2017: 36, 47). On this point, Nadoolman Landis (2012b: 16) argues that 'show, don't tell; when you can draw, don't describe.' Hence, the physicality of drawing relates to the costume design praxis, in which the costume sketch operates as a visual extension of the designer's mind and acts as a way to express different costume design ideas.

In live-action film productions, costume drawings demonstrate the development and the different options of the character costume design. Costume drawing can be an abstract, quickly created sketch done during the costume design development or a more finalised drawing that provides the costume's structure, details, colours, and often includes physical fabric samples to indicate the costume materials (see Malinen 2017). Costume drawings facilitate communication between the costume designer and the rest of the creative and production team, including collaboration between the costume designer and the director (Nadoolman Landis 2012b: 14). Furthermore, final costume drawings are shared with the professionals in a wardrobe department, who bring the design to life in a three-dimensional form. In such cases, costume drawings are visually informative in the collaboration between the costume designer and costume makers (see Nadoolman Landis 2012b). In the digital character's costume design development, costume drawings were shared with the director, as well as with producers, production designer, and art director. Final costume drawings are equally informative to the ones used in live-action films by illustrating visual evidence about the costume structure, shape, and materials, except that in computer-animated productions, this information is shared with the animators who digitally create the character costumes.

The costume designer's experiences in the case study films show that they developed the costume drawings based on the character's body shapes, which were visually presented to them at the start of their work or during a phase of a newly developed scene that involved new characters. Collaborative discussions, as well as supportive visual materials (i.e., concept art, story boards, mood boards), assisted the costume designers' work regarding the world of the film and characters' diverse personalities. Costume designers either developed the costume drawings on their own or collaboratively with the director.

Expressing costume ideas through the drawn form is related to perceptive understanding. In animation drawing, '[p]erception is often intrinsically related to cognition – literally, sometimes what you see is what you know' and drawing is a way to express one's perspective understanding of the world and what is seen (Wells et al., 2009: 23). The same applies to costume design for animation, as similarly the designers observe and draw, at the same time reflecting their own knowledge and understanding of what they see as a drawn form. Perception and perceptive understanding lie at the core of costume drawing, as drawings visualise the designer's ideas. For example, during the production of *Monster House*, Ruth Myers primarily developed the character's costume ideas together with director Gil Kenan. Kenan, who had worked on the film longer than Myers, already had a strong idea of the personality and the visual representation of the characters. In collaboration with the director, drawing was a tool for Myers to visualise the director's ideas that he presented in their conversations regarding each character, where Myers drew the ideas that the director expressed verbally. Myers (2017) remarks that 'for me to put things on paper physically is the only way I can really understand how to design a project,' which crystallises how a costume designer visualises the design ideas for the costumes.

The other case study film productions differed from *Monster House* in the ways that costume designers Mussenden, Segal, and Flynn worked on the costume development drawings on their own and presented their drawings in weekly production meetings.[34] These meetings involved team discussions with a number of people, including the director(s), producers, production designer, art director, sometimes animators, and scriptwriters. Most of the collaborative discussions in *Shrek*, *Shrek 2*, and *Shrek the Third* were held as video conference meetings because DreamWorks' animation department, Pacific Data Images (PDI), was located outside Los Angeles, where the costume designers lived and worked. However, some face-to-face meetings were involved, especially with the art director Aretos. During the production of *Big Hero 6*, Flynn physically presented his costume drawings in production meetings at Disney. In these meetings, the style of costume design drawings varies from a sketch type of drawings including written commentary (Figure 16) to more finalised artworks that include details of the costume's structure (Figure 17). Both of these types of drawings facilitate dis-

[34] The film productions of DreamWorks animation were also executed at PDI (Pacific Data Image) in Silicon Valley, CA. Mussenden and Segal live in Los Angeles, CA. During the production of *Puss in Boots*, DreamWorks and PDI were located in Glendale, CA, which is an area next to Los Angeles. This enabled Mussenden to have face-to-face meetings with the production team and to physically share and develop her costume drawings with the others (Mussenden 2018a).

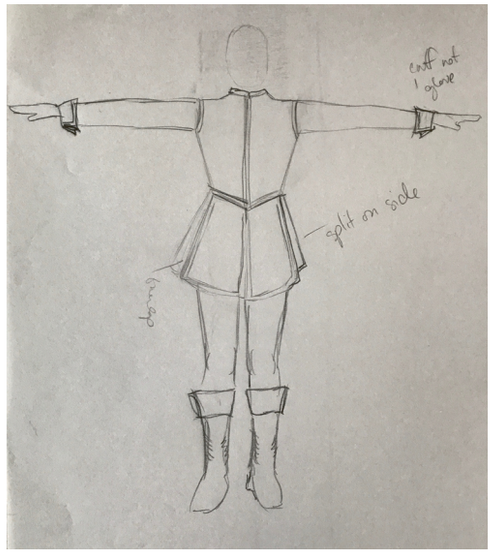


Figure 16. Israel Segal's costume drawing for *Shrek the Third* represents a quick sketch that mainly illustrates the structure of a garment and specific details with written commentary. Courtesy of Israel Segal.
Figure 17. Isis Mussenden's costume drawing illustrates a more finalised design with details of costume structure. Courtesy of Isis Mussenden.

cussions, involving a number of people, always including the directors, producers, and the production designer, who all observed the costume drawings and shared ideas on how to develop them further. Even though Mussenden, Segal, and Flynn created costume drawings on their own and Myers developed costume drawings with the director, in all cases, the drawn image was an extension and visualisation of the creative ideas of each designer's mind.

Costume drawings facilitated discussions in the production meetings regarding the different ways the designs relate to the character's physical and psychological nature, the film's narrative progression, and art direction. Consequently, viewing these costume drawings allowed everyone in the meeting to visually understand the different versions of the character costumes and the costume designer's ideas for the design. Mussenden (2016a, 2016c, 2018a), Segal (2017a), and Myers (2017) believed that very elaborate details and complicated structures were often omitted from the designs in order to achieve a more simplistic visual appearance and modest

Figure 18. Isis Mussenden's costume drawing for Princess Fiona in *Shrek 2* is from a costume design development phase and illustrates how costume drawings visualise the design ideas and facilitate discussions to develop the costumes. Courtesy of Isis Mussenden.

silhouette for the costumes. This links with the traditional animation drawing and representation, where drawings are often stylised and aesthetically restyling the real (Wells et al. 2009). In addition, costume drawings facilitate the discussions for further ideas for the costumes in the production meetings. Mussenden's costume drawing for Princess Fiona for the final scene in *Shrek 2* is an example of such a case (Figure 18). In this drawing, Mussenden has suggested a design including features from period fashions common in the late Middle Ages, circa 14th century in central Europe. The collaborative discussions concluded that these design ideas could not be included in her costume, which eventually differed from the original ideas in the computer-animated film. The reason behind the costume changes was partly due to software issues, which I discuss more in depth in Chapter 4.

Being able to perceive elements in costume drawings depends on 'the level of realism in the drawing, and the level of interpretation it demands' (Malinen 2017: 36). In the case of quick and sketched costume drawings, the viewer needs to know 'whether it is only acting as loose guidelines for mood and atmosphere, whether it is open to any adaptation at all or if the viewer has to interpret it in a certain way' (Ibid.). Collaborative discussions assist in explaining the visual outcome verbally. In addition, '[t]he viewer of the costume sketch needs to know whether the costume designer wants the costume to look exactly like the drawing' (Malinen 2017: 36), which primarily pertains to viewing final costume drawings. These remarks by Malinen show that collaborative discussion is an integral part of perceiving and interpreting costume drawings (and other visual materials). In the instance of final costume drawings in computer animation, these drawings must include as much visual information as possible because the costume designers are rarely involved in the production during the phase when the character costumes are digitally built (Mussenden 2016a, 2018a, Segal 2017a, Flynn 2017, Myers 2017). Collaborative discussions between the costume designer and the animator do not take place at this particular stage of the production. For this reason, the costume designers finalise detailed costume design drawings prior to computer animation. In addition to this, due to missing verbal discussions and collaboration, they pass on other visual materials to the animators, such as patterns, additional detailed drawings illustrating details in costumes, and physical material samples. I will discuss this process in detail in Chapter 5.

To conclude, in the costume design process for computer-animated films, costume designers employ costume drawings as a visual tool in the communication between other members of the production who are collaboratively involved in the character design development. Costume drawings are visually informative by indicating various costume ideas for the other members in the collaborative meetings. These drawings evolve as final costume designs that define the form and silhouette of the character, which are essential parts of character development in animation. In the costume design process, drawing is a physical activity that visually depicts design ideas for digital character costumes. The costume designers' interviews demonstrated that drawing was a communicative way to visualise the different design ideas. They facilitated discussions on how costumes connect with the narrative, how costumes convey the personality of the character, and the characters' personal story arches in computer-animated films.

Character development with maquettes

Maquettes, usually made out of clay, function as tangible, three-dimensional examples of digital characters' body forms and are used as part of character development in making computer-animated films. Maquettes hold multiple roles, for example, they assist in visualising the outcome of a character and in better understanding their body form and size in relation to the other characters. *Shrek*'s character designer Tom Hester remarks that maquettes resemble clay sketches, which enable the development of the character's design and examination of its 'entire form in front of you' (Hopkins 2004: 82). By having a physical object to represent the characters, three-dimensional shapes assist the development of the digital character. Maquettes are not only used in computer animation but also in live-action films that employ computer-animated (i.e., CG) effects as a way to test different design ideas for costumes and to examine them from each angle. Sometimes these maquettes include layers of fabrics to demonstrate the costume textures, which is difficult to show on a maquette that is solely sculpted from clay (Russell 2004: 192, 198).

In addition to visualising the digital character in tangible three-dimensional form, maquettes also play a role in the character development process, where the maquettes' shapes are transformed into a digital form.

Figure 19. One of the very first sculpted maquettes of the character Shrek. Designed and sculpted by Tim Lawrence and Loren Soman. Image source: worthpoint.com.

Once the characters' body forms are finalised as physical maquettes, they are 3D-scanned and refined on a computer as digital characters (Hopkins 2004: 86; Rinzler 2006: 2, Holliday 2018: 80, 128). The physical object examination first enables errors to be reduced on the body form before its creation in the digital form. When the characters are built digitally, thereafter, as Holliday (2018:80) nicely phrases it, the digital characters are 'inserted into the world (a process known as blocking), dressing the set with their residency.' The development of the character's physicality and personality continues in the digital world, where the costumes are also digitally built on the character's digital body.

The maquettes allow animators and artists to test out the character's physical proportions and develop the ways elements of its physical form might operate in relation to a character's movement. For example, the character Shrek's body was first designed with a large upper body and thin legs, which reflected on the original design of Shrek in the children's book by William Steig, from which the story originates. In the original illustration, Shrek had a thick neck; however, in the animated version, the character was unable to bend his head down. This challenge became evident through an examination of the clay maquette, which then enabled revisions to the character (see Figure 19). Subsequently, Shrek's body was altered into a more humanised form, reflecting better human movement (Hopkins 2004: 85). Over a hundred clay sketches were created before the design was finalised, while the voice actor Mike Myers' personal features, such as eyes and eyebrows, were also incorporated in the character's design (Hopkins 2004: 82).

As several production phases operate simultaneously in computer-animated films, such as character development and costume design, costume designers have the potential to participate and advise on the development of the character's body forms. Mussenden (2016a) discusses how she was involved in developing the body form of the character Fiona during the production of *Shrek*. She remembers that, at first, Fiona was designed with an unnaturally thin waist and an enormously large bust. The character's clay maquette showed these body features in 'real life' and presented their unnatural dimensions. At this point, Mussenden advised the head sculptor Tom Hester to improve the character's proportionality. Mussenden (2016c) explains that 'I was like: "guys, I'm not really sure the story is about that, if we remember what Fiona's story is about".' Thus, the costume designer recognised that the character's bodily form disconnected the character from the narrative and communicated such with the character animators responsible for developing the character's body form. Mussenden (2016c) continues that 'I was trying to find a balance of not that kind of kitschy superhero body type that is so unrealistic; it was so ridiculous she was so top heavy.' Due to Mussenden's advice, the character's body proportions were refined to a more natural shape, which aligned better with the character's personality, the story, as well as the 'humanised body form' style that was the vision for all characters in the film. The shape of Fiona's body at first adhered to the more traditional way of representing female body types in animation, such as the classical Disney princess whose body includes an unrealistically narrow waist, large eyes, and long hair (see Stover 2013). As *Shrek*'s story included human characters that were supposed to possess a more realistic human form in order to convey more truthful characters, Fiona's body had to correspond to this type of body form.

Similarly with Mussenden, Myers examined maquettes as part of her costume design in *Monster House*. Myers (2017) recalls that the tangible

character models allowed her to understand the character's form and proportions, explaining in Rinzler's (2006: 2) publication that 'my job was to help turn these models into characters.' The maquettes that are typically produced without costume demonstrate the three-dimensional shape of the body without presenting any deeper meaning of the characters, such as their different personalities. These features become evident through the costume; therefore, through costume design, the character's physicality and personality visually come to life.

The need for this kind of tangible material examination via the maquettes confirms that the somaesthetics, in this case experiencing a character's body form through touch, enriches the designer's understanding of the character's design, which is ultimately created digitally. Shusterman (2012) argues that attention to bodily experiences and methods enriches our aesthetic experience and practise. This enlightens the process of making aesthetic decisions regarding the digital character's body form through physically touching and examining the character prior to the computer animation. The tactile examination of the character's body as a maquette connects to the designer's somatic experience that guides the design process. The somatic experience broadens the understanding of the animated character's body form, enhancing it from an examination performed solely through vision. Hence, examining the character's body as a maquette conveys somatic and aesthetic experiences for the costume designers and animators, which guides the modification of the character's physical form and motion.

In addition to this valuable aspect of tactility, the three-dimensionality of maquettes contributes to a more thorough understanding of animated characters' body forms. Prior to digitising the maquettes, they offer a possibility for character designers to test the three-dimensional body form. This examination enables revisions to the body prior to computer animation. The three-dimensionality of a maquette allows costume design to physically see the shape of the body from all angles, to test materials and draping, and to envision costume on the body.

In *Shrek*, *Shrek 2*, and *Monster House*, maquettes were also built after the costume designs were completed. Mussenden (2016b) explains that in the *Shrek* films, these maquettes produced information for those in character development about the costume design, characters' body forms, and characters' sizes compared to the others. Myers (2017) recalls that maquettes were also constructed once her costume designs were complete, that is, once the final costume designs were accepted and no changes could be made to the designs. Her experience in live-action filming differed. Myers (2017) notes that seeing the maquettes, 'it is a fully completed thing and you are thinking, should I have made that decision, should I have done something else, could I have done it better. So, it is very early on to have to sign up on stuff.' The fact that the decisions on costume design are made at an early stage of the production and cannot be altered during costume creation is one of the key characteristics of costume design in animation in the context of the Hollywood industry. Not being able to observe the costumes on the digital body, maquettes offer a possibility for the costume designer to see the designs prior to leaving the production, which is before the stage when the digital animation is executed.

In conclusion, maquettes allow examination of the character's physical proportions in real life prior to creating them as digital characters. Studying the maquettes enables costume designers to physically see the character's body and develop costumes based on an idea of how the body form looks in a form other than digital. The development of the character's body through sculpting maquettes occurs simultaneously to costume design development, which offers a place for the costume designer to collaborate in developing the character's body form. The examination of the maquettes relates to somaesthetic practice, as touch expands the perceptive understanding, which the clay maquettes offer. The multisensorial experiences through touch and vision assist the costume design development before the characters are created in the digital form.

The analysis of the examples provided in this section has demonstrated that visual materials are a vital element of costume designers' work process and collaboration in computer-animated films. They operate as visual tools in communication between the costume designer and their closest collaborators, such as the director(s), producers, production designer, and art director. Out of the selection of visual materials, concept art offers information about the film's art direction, which illustrates the overall visual aesthetic style. For the costume designers interviewed for the purpose of this thesis, concept art proved especially valuable in showing a particular visual frame to which they could link the costume design development, including colours,

shapes, and textures, the film's 'design language.' In addition, concept art depicts the period(s) and location(s) in which the film is set.[35] The specific time and place offer the designers more details to better anchor their design development to clothing ideas and gain inspiration from a certain period, thus achieving a more coherent aesthetic design for the film. In addition to concept art, storyboards were supplementary visual materials supporting the film's art direction, especially in visualising the story development. The scenes are developed throughout a computer-animated production, and the costume designers reported that storyboards allowed them to better understand the changes in scenes.

This section also argued that mood boards broaden the visual information that concept art and storyboards convey by providing tactile examples such as material textures for the designers to use in costume design development. Hence, all the visual materials contribute to the communication between the costume designer and other members of the production. Costume designers also collaborate indirectly, therefore, with concept artists, storyboard artists, or character designers who craft these visual tools, as the costume designers observe their artistic work to develop the costume designs. At the same time, costume designers collaborate with the artists and animators who make the tangible visual materials. The collaborative input based on concrete visual and three-dimensional tangible materials enables all professionals in the production to progress and work towards the successful completion of the characters of the computer-animated film.

3.3 'Nothing underneath it exists': Absence of the actor in the collaboration

This section shifts the discussion to the absence of the performing actor in the collaborative character costume development in computer-animated film productions. The actor's presence is a natural part of costume design development in live-action filmmaking and live performance. In computer-animated feature films, the collaborative process between the actor and costume designer operates differently, without the performing actor's presence in the design process. This section demonstrates how the design of costume evolves without the actor, in a phase in which an animator takes the place of the actor (Wells 1998). I also discuss the value of costume as part of the animated character's performance, where the animator is considered the protagonist in creating the animated character's performance (Crafton 2013).

In live-action filmmaking and live performance, the collaboration between the actor and the costume designer often begins at their first meeting or during costume fittings. This dialogue between actor and costume designer is an essential part of the costume design development (Landis 2012a, 2012b, 2012c; Howard 2019; and Pantouvaki 2010). The collaboration functions both ways, not only assisting the actors but also the costume designers in developing their designs further. This is accomplished comparably in both live-action filmmaking and theatre productions. For example, scenographer Pamela Howard (2019: 89–91) leaves some room for the actors' own contribution towards the costume designs; consequently, she does not finalise any costume drawings before the beginning of the rehearsals. The costume designer assimilates ideas by reading actors' emotions and physicality on stage, and the final costume designs are completed after observing the actors' performance and during fittings. Costume design scholar Sofia Pantouvaki (2010: 110–112) also explains shaping a design based on the actor's physical characteristics and personality. In addition, costume designers are skilled at altering the proportions of the actor's body (or, more accurately, the impression of these) with a costume, for example, in designing and making costumes for non-human characters. In all instances, the actor's appearance and personality traits influence the costume design: its design reflects the impression of the actor's physicality and, frequently, their own perception of the character they impersonate.[36] In costume design for live-action films, costume designer Mark Bridges discloses his ideas on the design with the actor and finalises the costume designs after these important discussions regarding their approach to the character (Nadoolman Landis 2012a: 42). The actors themselves have also read the script and developed concepts of the visual look of the character in their own mind. On this point, Ruth Myers (2017) notes that 'it is very rare for an actor to just go "dress me"; they have

[35] I discuss the topic of costume designers' visual research in Chapter 5.1.

[36] Sometimes in animation, the voice actors facilitate the animated character's physical characteristics. For example, in the case of developing Shrek's facial features, the voice actor Mike Myers' personal facial features were implemented in the Ogre's design. Therefore, the element of voice is also one part of how characters are realised and performed; however, I do not touch this (also important issue) in my thesis. I concentrate on the central element of costume design.

read the script, and they have some idea of how they want to look… and you have some ideas of how you want them to look.' This vital discussion nurtures the costume design from a simple drawing to a physical garment that visually expresses the characteristics of the character.

In computer-animated film productions, costume designers participate in a different kind of collaborative design process, without the actor's contribution to costume design development. For example, Mussenden (2016c, 2018a) experienced that the actor's different features such as skin colour, body shape, posture, or the actor's possible personal wishes that usually influence costume design were not relevant in computer animation. Additionally, when Myers (2017) developed the costume designs for *Monster House*, she recalls never meeting the actors in person, which she claims 'was extraordinary, as I am used to work[ing] extremely close with the actors.' In her case, she experienced that the energy that she usually put into the communication with the actors in live-action filming was re-directed to collaboration mostly with the director. Even though the character animation in *Monster House* was performed by real actors as a result of its mocap production, Myers (2017) did not meet the actors during the costume design development. Neither the actors' body forms nor their performance in the mocap filming affected Myers' costume design development. The animated characters' body forms differed to those of the live actors; therefore, she concentrated on the form of the animated body and not on the actor's body performing the role for the needs of the mocap filming, which was primarily used to refine the animated characters' movement. Furthermore, the mocap footage was filmed after Myers left the production, so she did not see the actors performing the scenes live as part of the capturing of their movement and expressions. Thus, costume design development in computer animation is based on decisions driven by other professionals in the production than the actor, which re-organises the traditional collaborative costume design development process when compared to live-action filmmaking.

Costume design also holds a central place within the understanding of acting and performance in animation. The character's performance, commonly created by an actor in live-action filming or live performance, is created by the animators in animated films. Wells and Moore (2016: 94) note that regardless of the medium – hand-drawn, puppet, or digitally created character – the character's emotion and action stems from the animator's own contribution to the performance. This perspective is a common one in scholarship on animation, which primarily sees the animator or artist as the centre of the performance. Williams (2001: 326) even remarks that the animator's job is to 'get inside the character.' Crafton (2013) adds that in animation, the character's performance on screen is actually the interpretation of the animator's feelings and gestures. These statements argue that animators are responsible for creating the characters and bringing them to life. The animators embody the characters whose personality and performance are invented during the character animation. From a costume design point of view, when the character's physicality and especially performance are animated, the costume design should also be considered. However, commonly in animation scholarship, as well as in the animation productions, animation acting and performance fail to take into consideration the character costume design or to develop either with a costume designer, even though costume is a central visual element of the character.

In computer-animated films, costume visually illustrates the character's form, personality, and performance. Mussenden (2016c) described the ways she designed the costumes for the digital characters by saying 'nothing underneath it exists,' meaning that, underneath the costume of the animated character, there is not a physical body, nor "life". Where in the real world, our bodies are 'indivisible from a sense of self' (Entwistle 2015: 29), the digital character does not possess a physical or psychological self. These two essential elements of a physical human are fashioned by other means for the digital character. The animator is the key performer – the one who "gives life" to the character and replaces the absent actor who is present in live performances. Studies by Wells and Moore (2016), Crafton (2013), and Williams (2001) do not mention costumes at all, which supports the notion that costume design is generally not considered in bringing the character to life, despite the costume's value to this creation. In animation, costume generates ideas for the animator in character animation and performance. The fit of the garment, whether it is loose or tight against the body, or the weight and feel of the fabric against the skin, are all crucial aspects that affect the ways the character moves and feels. Different kinds of costume structures and materials produce ideas for a certain kind of movement. The costume's feeling on the body creates embodied experiences of wearing a garment for the animator who acts and animates the character performance. As earlier

explored in Chapter 1, animators have the autonomy of creating character performance. This study shows that the embodied experience of costume, therefore, is central to an animator's character performance creation.

The spectator's understanding of the character's performance is also dependent on what the character wears. The costume is focal in this perception as it illustrates the character's body form and also visually expresses their physicality and motion. Where in the real world, 'the body gives existence to the dress' and 'it is impossible to conceive of a dress without a body' (Gaines 1990: 2, partly citing Barthes 1972), in animation, it is impossible to conceive a body without a dress, as the dress is the body, where costume visualises the character's physical form. The animated character does not possess a "physical body"; however, the digital body becomes visible via costume and comes alive through the work of an animator who creates and acts the character's performance.

The analysis of the case study films shows that the character's acting and performance were developed by a group of professionals who participated in creating the character, including obviously the animator but also the production designer, art director, and sometimes the costume designer. On this point, Aretos (2017) remarks that no difference exists between designing and acting a character, 'because what you do as a designer is basically put yourself in the shoes of the character whose story you are telling, which is the exact same thing that you do when you are acting a character.' Aretos' comment supports the belief that the animator is not solely responsible for creating the character and its performance. Even though Wells and Moore, Crafton, and Williams equally argue that animators bring the character to life, it is, instead, a collaborative effort that involves other designers. Through the analysis provided in this study, I argue that the character animation and performance also include the work of a costume designer who is collaboratively responsible for creating the visual representation of the character. Neither of the costume designers interviewed for this thesis discussed being involved throughout the character animation phase, in which the digital character's acting in different scenes is created. The closest example on this point was Segal's costume design ideas created collaboratively with the director for particular scenes in *Shrek the Third*, where Segal suggested costume designs that facilitated ideas for the character's comedic performance. Another example of costume designers' being partly involved in developing characters performance is sharing physical garment samples to the collaborative team who develop the characters. I discuss this topic of physical material examples in more detail in Chapter 5, Section 5.3.

In sum, costume design appears essential for the development of ideas for acting and character performance in animation. Costume enhances the experience of an animator in embodying the character, as costume facilitates feelings on the body and affects movement. However, the value of costume design has not been fully implemented within the practice and production of computer animations. The costume designers' experiences show that they do not actively collaborate with the character animators while they act and create the character's performance. Costume designers are, therefore, unable to contribute to the performance with costume-related ideas about the action in scenes. I refer to the production schedule example by Winder and Dowlatabadi (2011) presented at the beginning of this chapter, which illustrates that character animation, a phase for acting and performance, is created in parallel with "visual development," a phase where the character's form and costume are developed. According to the production schedule, the animation phase, in which acting and character performance are developed, happens simultaneously to visual development. However, the case study films demonstrated that only Israel Segal proposed ideas for the character performance, but this occurred during script development and not in collaboration with the character animators creating the performance. Even though costume, its material, cut, and feeling on the body facilitate ideas for movement and performance, the costume designers did not participate in the production phase when the costumes are digitally animated and the character performance created. This provides clear evidence of the potential for involving costume designers throughout the animated film production and specifically during the character animation phase. By doing so, the character costumes could more strongly correspond with the action in the scenes and enhance the animator as an actor to embody the character also through costume.

3.4 Conclusion

The examples presented in this chapter have demonstrated the value of a costume designer to the collaborative labour involved in the production of computer-animated films. I have illuminated specific stages in animation production processes and how they intersect and affect the costume de-

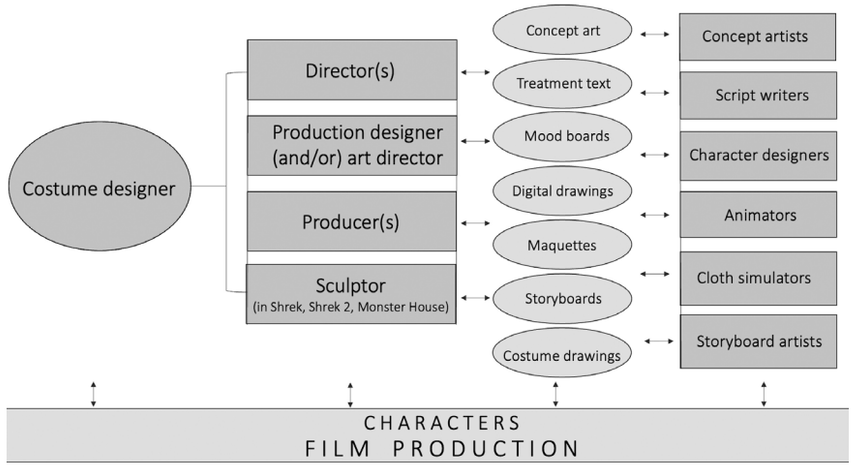


Figure 20. This figure indicates the costume designers' collaborators, the different professions that are involved in the design of the digital character costume, and the visual and textual materials that are part of costume design.

signer's work and costume design development. Also distinctive to digital character costume design is that due to continuous script development, less information is given to the costume designers regarding the film's narrative and its characters. As a consequence, more frequent and tight collaboration with several professionals is required to share information regarding the film's aesthetic world and characters, where costume designers play a significant role. This means the inclusion of a range of visual materials, such as concept art, mood boards, costume drawings, and storyboards as part of costume design development, which all function as supportive visual materials for costume design and as visual tools in collaborative design meetings (see Figure 20). Due to continuous script development, characters can be either removed or added to a film, which consequently influences the costume design development. Costume designers respond to the constant changes in the film's script and rework the designs multiple times; this emerges as one of the characteristics of digital character costume design and the collaborative animated filmmaking practice.

The variety of visual materials used in collaborative discussions in computer-animated film productions enhances the understanding of the films' aesthetic design and narrative. The costume designers themselves did not always produce the visual materials used in the collaborative filmmaking; consequently, they collaborated indirectly also with concept artists, storyboard artists, and animators by exploring visual materials crafted by those professionals (see Figure 20). Visual materials such as concept art assisted the costume designers' understanding of the films' design style, location, and time period, whereas mood boards brought more tactile dimensions to the visual materials. Mood boards included material samples that enriched the sense of texture qualities that can be included in the costumes to connect with the aesthetic quality of the film. I proposed that examining tangible textures in mood boards connects to the perception of what we see via somaesthetics. Each designer reflects on tactile experiences in their own way; for example, rough or smooth texture surface transfers feelings that stem from their personal past and experiences, which together guide their choices for character costume designs. The tangible materials increase the experience from perceiving solely visual materials, for example, in concept art.

The act of drawing proved to be a notable visual tool for the costume designers to visualise their costume design ideas. Costume drawings, on the other hand, expressed the different notions for the character costumes, and these were shared in collaborative discussions between costume designer, director, producers, production designer, and art director. The visual reference materials such as concept art, storyboards, and mood boards guided the costume designer's design development while they worked on the costume drawings between the collaborative meetings. During costume design development, costume designers transfer ideas gained from perceiving visual reference materials to their own design development. Even though the costume designer's modes of working and employing various visual materials differed, each designer benefitted from observing and examining visual materials and further interpreted these in the costume design. For each of the designers, art direction and concept art appeared to encompass the most essential visual indicators in their costume design development and design collaboration.

Numerous script revisions in animated film production, on the other hand, offer an opportunity to include a costume designer as part of scene development. It was evident that the costume designer's presence in the collaborative scriptwriting process enhanced the possibility of bringing costume design–related ideas also into the scenes. However, this collaboration did not continue into the animation phase, when animators act and create

the character's performance. The animation acting and performance creation are executed during a phase when costume designers are no longer engaged in the production. It was evident in the case study films that the ideas for the animated character's performance were created collaboratively but without the costume designer's presence. The way costume reflects on the character's physical performance is vital to consider as part of the development of the character's different personalities and motion. As with actors in live-action filming, a particular costume helps bring the character to life and facilitates ideas for movement and emotion. Similarly in animation, costume can function as an integral part of character animation to assist the animators in embodying the characters they bring to life. This next chapter moves the discussion from collaborative costume design into the context of digitally animated costumes, and to the role of technology development in digital characters' costume design. It also includes insights into collaborative animated filmmaking, where costumes are built by professionals other than costume designers via animation software.

CHAPTER 4

CHAPTER 4

DIGITALLY ANIMATED COSTUMES

Costumes in computer-animated films are technological entities that require closer examination, specifically their development through the various stages and evolution of a film production. In particular, I investigate the development of specific software and the effects of computer programs on the form, structure, and surface texture of the costume. Designing costumes within the parameters of digital technologies is the focus of this chapter.[37] Technology forms an integral part of the animation industry and is central to the creation of convincing character clothing and costume design. Intense competition between animation production companies over the last 20 years has triggered growth in the development of animation software, which has supported the design and increased visual realism of animated worlds, environments, and characters (see Moszkowicz 2002). These innovations also include the effects of computer graphics and digital imagery in shaping the realistic accuracy of character costumes. Research and software development in cloth simulation systems in particular have been undertaken by the animation industry, resulting in greater authenticity in character costumes.

[37] The input of several animators working on the computer programs that execute costume's cloth, texture, and motion ties into the previous chapter's discussion on collaboration.

I argue that perceptually authentic costumes not only enhance the character's visual representation but also contribute to a more believable performance. Both aspects clearly contribute to the success of animated films and are also part of the industrial competition between film production companies. For example, more realistic and sophisticated depictions of digital clothing result from developments in cloth collision caused by the movement of costumes in characters' motions (see for example Govindaraju et al. 2005; Baraff et al. 2003), creating believable fabric folds and wrinkles (see Miguel et al. 2013; Deshmukh et al. 2017; Cutler et al. 2007), or more accurate material depiction in the cloth textures (see Aliaga et al. 2015; Clyde et al. 2017). Each development in software impacts digital characters' costumes, making them more visually complex in their material depiction and behaviour.

The software developed for creating costume structures and adding texture on cloth is, in fact, also used to build the environments or the surfaces of non-human characters, or vice versa, suggesting its value beyond the rendering of costumes. For example, in *Frozen 2*, cloth simulation was included in the techniques that achieved the surface texture on the water horse, which depicts flowing water (Failes 2019). Pixar used their Bump-to-Roughness (BtoR)[38] technique, which assists in preserving fine details on cloth and adds realism and structure to garment shading, to maintain the authenticity of the dinosaurs' skin in *The Good Dinosaur* (Sohn 2015). The software was also used to replicate accurately the details of metal flakes and scratches on the cars' surfaces in the Pixar film *Cars 3* (Fee 2017), and later employed to create realistically shiny fabrics on the superhero costumes in *Incredibles 2* (Crow et al. 2018). Thus, the technologies producing cloth can be employed across departments in animated film production in building different kinds of surfaces and environments.

Evidently, the relationship between costume design and technology is complex, as technology enables the creation of imaginative costumes but also brings certain parameters to costume design. Julia Moszkowicz (2002: 305) notes that 'science and technology alone set the parameters of the possible within digital animation,' which offers an interesting topic to examine from the costume design perspective. This chapter delves into the impact of technology on the design of costumes for animated characters and

[38] The Bump-To-Roughness (BtoR) technique enabled layering of multiple vector patterns that created a textured pattern effect on Helen's superhero suit in *Incredibles 2* (Crow et al. 2018).

focuses on how computer-animation software influences costume design choices and designers' work. The case study films' production years establish a range in time that can be used to identify the technological development in the costumes. This continuum begins with *Shrek*, the first of the case study films, released in 2001, and ends with *Big Hero 6*, released in 2014. The case study films chosen for this research therefore offer the possibility of making connections across specific animation studios, or within a franchise, and analysing digital character costume design specifically from the costume designer's perspective. My observations and analysis in this chapter stem from the costume designers' interviews, analysis of costume design development drawings, and the final outcome of the digital costume in the case study films. By focusing on the technological dimension, my analysis demonstrates the transformation of costume designs from an initial design sketch to a digitally created costume.

The costume designers' interviews brought to light their many contributions to the development of costume designs for the digital characters, as well as the visual and structural parameters on costume design decisions and choice of materials produced by the medium of computer animation and the development of the software. In this chapter, I first discuss how the costumes were constructed on the digital characters' bodies and how the development of technology shaped this process. This section illuminates the process of design and construction of costumes on digital characters' bodies in the case study films. I then elaborate on how the costumes were built as specific costume models used multiple times on a character. The second section shifts the discussion to the design of these costume models in the case study films and concentrates on technology's effect on digital character costume design development. In particular, I concentrate on the effects of cloth collision on costume design development and the resolution of these computer animation–related issues by costume designers. The third section in this chapter moves the focus from costume's form and structure to cloth surface textures and explores how the physical condition of costumes is executed on the digital character costumes across the case study films. I emphasise the multisensorial quality of perception and consider the ways in which visual perception of digital costumes evokes other senses such as touch, smell, and embodied memory. In the final section, I describe costume design for "generic characters", meaning the "extra" characters that perform as essential characters in the computer-generated crowd scenes.

Multiplying characters digitally to create the appearance of a large crowd is achieved with computer animation software. Additionally, the use of pre-defined costume models contributes to the creation of costumes for these generic characters.

4.1 Digital costume models

In the previous chapter, I discussed how animated characters' body forms are at first designed as physical maquettes and their body forms digitally animated thereafter. Costume designers develop character costumes based on the shape of a maquette and a digital body form. Once the costume design is decided for a character, the structure of the costume is constructed on top of the character, resembling a digital line drawn on top of the character's body that indicates all the seams, details, and outer lines, which creates the silhouette of the costume. The seams on digital costumes are "sewn" together similar to that in a real garment, meaning that digital garments also include seams, darts, and pleats, and these are treated on a computer similar to sewing a physical garment. However, the costumes are not "dressed" on the digital body in the same sense that humans put clothes on a body, adding one physical garment over another. As I will explore later in this chapter, digital costumes illustrate the character's physical form and are integral to their body.

Digital costume structure shaped over the digital body form differs from a real garment. In addition to the seams in the digital garment, the outer line of the costume that divides the costume and the character's skin creates another kind of "seam" or intersection. This intersection builds the division between the costume and the character's body, and in fact, only colouring divides the visual appearance between the character's skin and costume. Due to this tight connection, the digital character and its costume are indistinguishable from each other. On this point, in the frame of performance of actors in the real world and acting on stage, Monks (2010: 11) argues that there exists an essential perceptual indistinguishable connection between an actor and costume, as 'when a costumed actor appears on stage, it is often very difficult to tell where the costume leaves off and the actor begins.' The actor's physicality merges with its costume, and together, they form the character. The form of digital character costume is built the same way. Monks (2010: 20, 33) continues that '[t]he borders between the actor and costume are unclear' and that 'in the end, there is no difference between actors and their costumes.' I argue that the structuring of costumes on the character's digital body makes the character and costume indistinguishable, as the costume construction, the lines showing form and structure, is connected with their digital skin.

In the case study films, the costume structures were constructed digitally on the characters' bodies in similar ways. In the costume design development in *Shrek*, Mussenden (2016a, 2016c) explains that after finalising her costume designs for each character, costumes were "constructed" directly onto digital bodies. However, the process of digitally creating the shape and design of a costume, such as computer-animating the form of the neckline, sleeves, and hemlines, was time-consuming. For this reason, if the narrative required a costume change in the film, any alterations on costume structures were minor, and it was not uncommon for one digital costume to be re-used in different scenes. The appearance of a "new" costume was achieved by retaining the same structure of the digital model, but changing the colours, prints, and materials. In *Shrek*, this repetition of costumes is visible in the costume design of Princess Fiona and Lord Farquaad. In the case of Lord Farquaad, the ruler of Duloc and the main antagonist in *Shrek*, he is first introduced in the film wearing a red, tight-fitting tunic with puffed sleeves and tight hose. Later in the film, in his attempt to marry Princess Fiona to become king, he wears a white and gold costume ensemble, which in fact retains the same structure as his red costume ensemble earlier in the film (Figure 21 and 22). Mussenden (2016a) recalls that she was required to retain the same

Figures 21 and 22. Lord Farquaad's costume change in the film *Shrek* was accomplished by re-using the same costume structure and changing the colours of the costumes. Screenshots (cropped) from *Shrek*.

structure in these costumes in two very different scenes and execute the costume change by replacing colours on the costume. To reflect the aesthetic design in the wedding scene, Mussenden changed the red colour to white and gold and also designed a gold diamond print on Lord Farquaad's tunic. The strong change in the colour and fabric print visually created a different appearance and established an illusion of two different costumes, despite possessing an identical structure. Similarly, Princess Fiona's iconic green dress changed into a white and pink wedding gown at the end of the film, while retaining the same design. The repetition in the style of these costumes was facilitated by the computer technology.

It seems that in *Shrek*, it was significantly easier to alter the colour and print design on the costume with existing computer software than to revise the entire costume structure. Arguably, the digital seams on the costume and the intersection between the digital costume edge and the skin create a "costume model", a term that I establish to define the digital costumes. A costume model consists of the costume structure and silhouette, essentially the overall design of the costume that can be re-used several times during a film. The costume model of Princess Fiona's dress in *Shrek* was also used in *Shrek 2*, as explained in the following paragraphs, and this is evident from Mussenden's (2016b) interviews and closely observing the two computer-animated films. Industry discourse also supports my observation, as Cutler et al. (2007) emphasises that in *Shrek* films (and in computer-animated films in general) 'it is not necessarily practical in a production environment to simulate every single costume on all the hero and crowd characters in a film,' and it is more productive to multiply the same costume models in the film and across films. Consequently, as in *Shrek*, the costume changes for the characters in *Shrek 2* were achieved by similarly retaining and re-using the same costume model and simply changing the colour.

In contrast to the previous film, however, *Shrek 2* advancements in computer software enabled the design and creation of elaborate prints and fabric texture finishing on the costumes to enhance the appearance of a new costume when the costume models were re-used. This highlights the capabilities of computer animation to facilitate the costume design process and the visual outcome of digitally animated costumes within contemporary animation. DreamWorks developed their own "fabric shading model" (Glumac and Doepp 2004) that was used on cloth material shading in *Shrek 2*. This model allows light to be depicted from a small patch of digital textile fibres, which creates an illusion of certain fabric textures. The new type of cloth material shading achieved different kinds of fabric appearances, including fabric thread direction, orientation, roughness, and colour (Deshmukh et al. 2017). The depiction of cloth and texture to add greater visual realism to costumes has evidently been an industry goal for technology. In 2002, Moszkowicz wrote that *Shrek* presented stunning realism with unseen complex CGI (295); however, the film's sequel took a leap in technological development and significantly increased the level of depth and texture in the animated costumes. The technological advancements also enhanced costume design by offering more possibilities for Mussenden to select materials, textures, weaves, and prints that reflected the character's identity and the visual aesthetics of the film.

Figures 23 and 24. Fiona's two dresses in *Shrek 2* have an identical structure and design, demonstrating that the same costume model was re-used for her costumes. The costume change was executed with different colours; however, in contrast to the previous film, fabric textures enhanced the differentiation of these two costumes. Screenshots (cropped) from *Shrek 2*.

An example of the ways these new kinds of textures were employed in the re-used costume models in *Shrek 2* is evident in the comparative visual analysis of the costumes for Princess Fiona and the Fairy Godmother. Within the narrative of the *Shrek* franchise, Fiona has two body forms, one as the princess and the other the ogre.[39] Fiona performs primarily as an ogre in *Shrek 2*, a body form in which she has three costume changes. Figures 23 and 24 illustrate the bodice of her first two dresses, created by re-using the

[39] For more on Fiona's personality, her different body forms, and the ways that costumes connect with the body and her personal identity, see Section 4.2.

Figure 25. Fiona's dress in *Shrek*. Screenshot (cropped) from *Shrek*. **Figure 26.** Fiona's dress in the final scene in *Shrek 2* has been made using the same costume model from the previous film. Screenshot (cropped) from *Shrek 2*.

same costume model. Both dresses have identical necklines, puffed sleeves and cuffs, and a V-shape belt dividing the bodice from the skirt. The differentiation between these two costumes was again achieved by processes of re-colouring, as well as through creating believable depictions of different fabric textures. Fiona's first dress at the beginning of the film suggests a linen material, similar to Shrek's tunic, mostly visible in the close-up shots. The decorative green ribbon ties to her green dress in the previous film (see Figure 25). Fiona's second dress, worn when she arrives at the castle to stay with her parents, the King and Queen, depicts a velvet fabric in two green tones. The velvet material of this dress reflects her regal status and the green colour her pre-established colour range. However, the design and textures are modest in order to connect with her past life, the ogre living in the swamp.

In fact, Fiona's third dress in the finale scene of *Shrek 2* copies the same costume model from the previous film (see Figures 25 and 26). The design is slightly altered around the V-shape waistline and hem, and a new type of fabric surfacing is added to generate a different look for the dress.

This clearly proves that the costume models are also re-used across films. Re-using the costume models reflects continuity between the films, which supports the *Shrek* franchise and the character's established visual identity through costume. Furthermore, this technique highlights the importance of character silhouette (see Crafton 2013), which is key to character recognition. By re-using the costume models, the silhouette remains identical and provides visual continuity, but new colours and textures give the impression of a new costume. Given the importance of silhouette and re-using the same design in one film and across films, it is important to focus on the design of the costume.

The re-use of costume models also occurs with the character of Fairy Godmother in *Shrek 2*. Her costume change in the film is executed with two dresses possessing an identical structure (Figures 27 and 28). As with Fiona's dresses, the variation between these two costumes was achieved with different colouring and sophisticated fabric depiction supported by advanced computer software, such as DreamWorks' "fabric shading model" (Glumac and Doepp 2004). This software enabled the depiction of Fairy Godmother's light blue dress with a subtle floral pattern and a fine lace on the neckline. These details visually convey gentle characteristics and are used as part of the narrative development to mislead the other characters and the spectators from her true villainous nature. In the film's final scene, where she sings on stage at the banquet of Prince Charming (her son) and Princess Fiona's wedding attempt, she wears a red dress with a glittery sequined surface. This contrasting colour and fabric texture produces an entirely different visual

Figures 27 and 28. Fairy Godmother's two dresses have an identical shape; however, the appearance of two different costumes has been achieved with different colouring and texture finishing. Screenshots (cropped) from *Shrek 2*.

Figure 29. The costume model for the Fairy Godmother's dress in the final scene has been altered at the hemline. Screenshot (cropped) from *Shrek 2*.

look from the previous costume, from a subtle one to a shimmering performance dress. Neither dress is period inspired, however, nor do they align with 14th century fashions as do the other costumes in the film.

Compared to other scenes in *Shrek 2*, the Fairy Godmother's costume model was changed slightly at the hemline for the final scene. The change is visible in the figure-hugging shape, while the skirt includes a revealing slit (Figure 29). Notably, in our discussion, Mussenden (2016b) explained that she did not contribute to the design of this red dress and saw it for the first time on the film's opening night. Mussenden was disappointed in this costume design as she thought that the change in the dress's form (skirt volume and slit), in addition to the sequined fabric, disconnects the costume from the period costume design that Mussenden employed in all other character costumes throughout the film. The purpose of this incongruity might have been that the dress visually reflected the party in the final scene where the Fairy Godmother sings on stage. The design of the dress resembles Jessica Rabbit's sequined gown when she performs on stage in *Who Framed Roger Rabbit*. This anomaly provides a clear example of the consequences of costume designers' not being engaged throughout the entire character design development and animation process in computer-animated filmmaking. As I discussed in the previous chapter, within computer-animated film productions, costume design is partially developed in parallel with character animation, a production phase when the character's performance is also created. However, costume designers' oral testimonies supported the fact that they were no longer engaged in the production when the characters are digitally animated. The Fairy Godmother's costume design is an example of such a case of a costume design suffering alterations without the costume designer's presence or feedback.

A re-use of costume models as part of costume change is also visible across the *Shrek* franchise and in *Big Hero 6*. One example appears in *Shrek the Third*, although the film production benefitted from improved software. Maya Cloth allowed for more layered clothing, and advancements in surface shading software created a variety of more detailed surface textures than in the previous *Shrek* films (Seymour and Montgomery 2007).[40] In *Shrek the Third*, three of Fiona's costumes, as well as those of the Queen, are identical in their structure but different in colour and fabric texture. In fact, a closer examination of Fiona's dress shows that in the King's deathbed scene, her dress structure is re-used from *Shrek 2* (see Figure 30). This suggests once again that costume models are used within and across films, adding continuity and coherence in costume design between the films. The similar re-use of costume models as part of a costume change is also evident in *Puss in Boots*, in which Humpty Dumpty's two costumes include identical costume models. Furthermore, in the case study film *Big Hero 6*, the character Go Go Tomago wears the same shirt model that changes from neon green to white, which provides a visual reference to denote the progression of time in the film.

The colour change in the re-used costume models in *Shrek the Third* not only visually generates a different "look" for a costume but also connects to a particular mood in a scene. When Fiona stands at her father's deathbed in her dark green costume, it is a re-used costume model from the previous *Shrek* film. The Queen also wears a gown whose style is closer to 20th century fashions than the Middle Ages, which was employed in some of the other costumes in the film. Her dress is a mix of grey and turquoise with a subtle shiny surface and elaborate metallic pattern (Figure 30). The colours and textures in both costumes reflect their regal status and the melancholic

[40] The development of software is also evident from costume designer Israel Segal's interview and by analysing the costumes in the film.

Figure 30. This figure indicates that the character costume colours and textures on Fiona and the Queen reflect the melancholic mood in this scene. The advancements in computer animation software, such as DreamWorks "fabric shading model", enabled an accurate depiction of different material textures also in specific lighting, visible in this scene. Fiona's costume model in this scene is re-used from the previous film *Shrek 2*. Screenshot from *Shrek the Third*.

mood in the scene. Although Fiona's costume structure originates from the previous film, it has been refreshed by adding woven floral patterns on the bodice. As Deshmukh et al. (2017) point out, '[s]ince *Shrek 2*, DreamWorks artists have used the fabric model developed by [Glumac and Doepp 2004] extensively on cloth material shading.' Although the company later developed new techniques (see Sadeghi et al. 2013) to accurately convey different material qualities, the user-friendly fabric model continued to be part of the character costume creation workflow. This suggests that the same model allowed for the execution of these rich details on the costumes worn by the Queen and Fiona.

In the scene following the King's deathbed, the Queen and Fiona's costume structures are identical to the previous sequence, indicating once again re-use of the same costume models. However, the costumes have a new appearance, which Segal (2017a) recalls: 'previously she has a mourning look … after he [King] dies, it is more sombre.' The subtle change in the costumes of the Queen and Fiona supports the dramatic change in the plot, in which the characters grieve at the King's funeral. In order to create a new visual look for these costumes, the colour of the Queen's costume is switched to a grey tone and the woven pattern design simplified to have fewer decorative ornaments than the one depicted in the previous scene. Similarly,

Figure 31. During the King's funeral, the Queen and Fiona's costume colours and textures are changed to dark grey tones with a less elaborate pattern on the dress fabric. Screenshot from *Shrek the Third*.

Fiona's dress colour is altered from green to dark grey, and it includes black and dark metallic details (Figure 31). These relatively simple changes in the costume texture and colours enable the character costumes to support the mise-en-scène without changing the entire design of the costume.

These costume examples from the two scenes in *Shrek the Third* are, in fact, achieved in a way that responds to the application of costumes and costume design in classical cinema, in which 'every element is in the mise-en-scène – from painted backdrop to prop to lighting cue – serv[ing] the higher purpose of the narrative' (Gaines 1990: 180-181). The term mise-en-scène refers to 'the spatial organisation of a film' (Rose 2001:48), in which the director *stages the event* for the camera 'including all aspects related to the scene: the setting, lighting, costume, and the behaviour of the figures' (Bordwell and Thompson, 1979: 75). Costume design provides visual support in relation to the specific staged events. For example, in an emotional scene, character costume can provide a strong visual connection through certain fabrics and colour (Gaines 1990:181). The change in the colour and textural details on the Queen and Fiona's costumes in *Shrek the Third* shows a similar attempt to reflect the mood in these scenes with costumes, which builds a

stronger connection to the specific atmosphere in the scenes and the characters' feelings. The majority of the animated films present characters wearing only one costume throughout the film, and costume changes that reflect the mise-en-scène are rare. However, *Shrek*'s production designer Guillaume Aretos (2017) notes that costume changes in computer-animated films are executed 'in terms of the state of mind of the character and the psychology of that scene,' which does connect with the idea of mise-en-scène. However, this clear example of a costume change between scenes in *Shrek the Third* is not visible in any of the other case study films. Since *Shrek*, animation software has allowed costume changes to be made in similar ways, so it seems that films have not grasped the potential of a costume change as dramaturgical support. As the previous examples showed, when aided by technology, it is relatively simple to create a new costume by re-using the virtual costume models and modifying this design by altering the costume colours and textures. Arguably, as in *Shrek the Third*, executing more costumes changes provides better visual support in scenes, reflecting both the character's emotions and the mood.

When the costume structure remains the same throughout the film, and only the material colours and prints change, it is vital that computer-animated films focus on the design of the digital costume models that are re-used from scene to scene, or even from film to film across a broader film franchise. The design of the costume distinguishes the character and contributes to their recognisability to the audience. My findings align with Crafton's (2013: 48) remarks that it is essential to distinguish the form of the animated character and retain this form throughout the film to support the audience's recognition of the character. Crafton also points out that a particular character shape and silhouette enable the character to stand out from the other character shapes. Certain costumes help maintain a recognisable silhouette.[41] Notably, the character silhouette is formed primarily by the costume's outer line and the body figure, confirming a perceptually indistinguishable connection between the digital character and costume.[42] The silhouette is vital for the audience in their perceptual definition and understanding of animated characters. As the costume creates the character silhouette, great importance must be given to the design of the costume.

[41] Equally with hand-drawn animated characters, the silhouette is important for the definition of the character and more emphasis therefore should be placed on the design of the costume.

[42] In stop-motion animation, costumes equally align with the characters' body form where the making of costume should 'operate in tandem with the puppet's armature' (Boumaroun 2018: 18).

In conclusion, according to my analysis, the costumes in computer-animated films contain digital costume structures that I classify by the term "costume model". These costume models are re-used within a film or across films. A "new" costume that illustrates a costume change is created by changing the colour and texture. Computer animation software development, such as the DreamWorks' "fabric shading model" have enabled a more accurate portrayal of textured surfaces and prints by adding certain lighting on costume textured surfaces. Such advancements enhance the visible difference between costumes when the character costume change was accomplished by re-using the costume model. Creating richer textures on costumes helped the characters bond with changes in the scenes and the costumes' connection with the mise-en-scène. However, this kind of costume change was accomplished only in *Shrek the Third*. The re-use of costume models across films created continuity and coherence for the characters between films. Specific costume models strengthen the visual image of the character and silhouette to a particular character design, which enhances the memorability of the character. Technological developments in the software have influenced the costume model's form, which I explore further in the following section.

4.2 The effect of computer animation software in the design of costumes

In the animated world, all surfaces are digital, and the structures and their outlines create intersections between one another. There is no difference between the intersections of cloth, body, or the environment where the character is placed. For example, costumes have intersections in areas where digital material, the cloth, is located next to another material, such as the skin of the body. When the digital character's arm rests next to the body, the line between the sleeve cloth and the cloth on the bodice also creates an intersection. In the case of digitally animated costumes, it is more challenging to animate a costume with volume because the cloth surface intersects with itself via seams, folds, and pleats (Baraff et al. 2003). The ways these dif-

ferent intersections function on a digital character's costume is called cloth collision. Self-collision occurs when the cloth collides with itself on the parts where there are wrinkles or folds on the garment. In addition, object-cloth collision occurs when cloth intersects with a rigid object such as a character's body or an environment such as a digital ground.[43] In short, collision restricts the digitally animated materials' behaviour from how it behaves in real life. Govindaraju et al. (2005) note that creating and moving cloth believably in high-quality computer animation requires a complex digital cloth, leading to many collisions. In such cases, '[e]ven a single missed collision can result in an invalid simulation and noticeable visual artifacts, such as cloth passing through itself.' Problems appear in the cloth simulation process, for example, when a loose material responds to character movement or touches rigid surfaces such as the ground (see Carignan et al. 1992; Govindaraju et al. 2005; Tonnensen 2009).

Such collision issues in costume are visible in the clothing of the *Shrek* films, particularly in their creating believable cloth in large volumes, which impacted the film's period costume design. Hence, as discussed in the previous chapter, *Shrek* takes place at the height of the Middle Ages, circa 14th century in Northern Europe. To create a more coherent visual style in the film, Mussenden (2016a) responded to the historical costume elements from this period in the costume design development. She examined historical and fine art books of period clothing and adapted visual references from garment construction, colour schemes, and material textures in her costume design.[44] However, it became evident during her costume design development for Princess Fiona and Lord Farquaad that computer animation was not advanced enough to create the common elements of 14th century fashions[45] – dresses with trains, long hanging sleeves, or floor length capes – such as those depicted in parchment illustrating men and women circa 1450 (see Figure 32). These types of garments all have volume, which creates cloth collision. Mussenden (2016a) comments on designing hanging sleeves that 'I could not do that because you have to animate also what is inside the sleeve, where you

[43] For more on cloth collision, see Baraff, Witkin, and Kass 2003; Volino and Magnenat-Thalmann 2000.

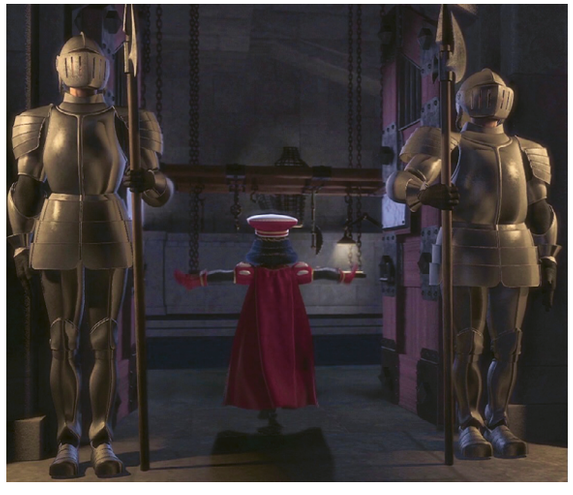
[44] For more about how visual materials are inspirational for costume design, see Chapter 5, Section 5.1.

[45] Shrek focused loosely on a time period after 1260 until around the 14th century in Northern Europe. The 14th century was already the Late Middle Ages in Central Europe and early Renaissance in Italy.

Figure 32. A parchment depicting the *Story of Alexander the Great*, circa 1450, illustrates women's fashions from the High Middle Ages in Northern Europe. Unknown artist, held at the Bibliothèque Nationale de France, Paris. Image source: Bibliothèque nationale de France, Public domain, via Wikimedia Commons.

see the hand go one way or the other.' Large volumes of cloth and how the cloth moves independently outside the digital body therefore created issues with cloth collision, such as the cloth moving through the digital arm or colliding through the dress.

In the case of Lord Farquaad's costume, Mussenden originally designed him a long floor-length cape, depicted in her costume drawing in Figure 33. However, due to object-cloth collision, a problem arose when the digital fabric intersected the surface of the digital ground. This intersection between the cloth and the ground created such collision issues that the design could not be executed. The limitations of the software simply did not support this kind of design. Furthermore, Mussenden (2016a) wished the cape to drape over Farquaad's shoulders; however, this design was also impossible to accomplish due to issues with object-cloth collision. She explains that the cloth of the cape could not cover the intersection on the shoulder that was key to animating the arm movement. Consequently, Mussenden altered the cape design, which in the final animation was shorter, had less volume than in the original design, and was draped on the shoulder in a way that did not break the shoulder intersection nor interfere with the animation of the arm movement (see Figure 34).



Figures 33 and 34. Isis Mussenden's costume drawing for the character Lord Farquaad shows that she originally designed him a floor-length cape with plenty of volume. However, the character's cape was created much shorter and narrower in the animated film due to cloth and object-cloth collision issues. Figure 33 courtesy of Isis Mussenden; Figure 34 screenshot (cropped) from *Shrek*.

Similar cloth-collision issues to Lord Farquaad's cape design also influenced the costume model of Fiona's dress in *Shrek* (Figure 35). In particular, the dress styles from the High Middle Ages, such as wide and long sleeves or long, draped hemlines (see Figure 32) simply could not be included in Fiona's costume design. Once again, this kind of loose cloth is problematic in folding and draping realistically because the cloth collides with itself. The cloth can also collide through another type of "rigid" surface such as a moving digital body (Baraff, Witkin, Kass 2003). Thus, the cloth that moves outside the body form has to be animated independently, which consumes more time than creating a tight garment on the body with fewer collision issues. Therefore, Fiona's dress design could not be floor length, which would have better reflected period-specific costumes. Similar to the cape, the cloth could not intersect with the ground as it created collision problems as well. For this reason, Princess Fiona's costume design included tight-fitting sleeves not covering the intersection on the wrist. Furthermore, the dress has less volume and is shorter than was common in women's dresses in the Middle Ages.

Figure 35. There were only a few period elements from the height of the Middle Ages in Princess Fiona's costume because of the cloth collision effect in simulation and computer animation. Courtesy of Isis Mussenden.

Another aspect that limits the use of large volumes of cloth in digitally animated costumes is secondary motion, which is a supplementary or consequential movement that results from another motion. Lapidus (2012: 192) explains that 'secondary motion is any movement that comes after the motion; this is initially directed by the character, animal, machine, or object.' In the case of costumes, '[w]hen a walking woman wearing a long dress suddenly stops, the gown might flow around her for a few seconds before coming to a rest' Lapidus (2012: 192). Consequently, any loose fabric that is not tight on a body and integrated with primary body movement requires further examination for the secondary movement of cloth and interpretation for character animation to achieve realism. In addition, a piece of clothing that hangs outside a body creates secondary motion when the character moves, when the wind blows, or is affected by other characters' action. Secondary motion causes longer animation time and, as previously noted, collision issues with all kinds of loose cloth in costumes. However, secondary motion in costumes is crucial in adding realism to character performance in animation.

Due to the limitations caused by the computer animation medium, Fiona's dress lacks a strong visual connection to period costume design and to a specific time and place. Historical costumes are one of the principal techniques for evoking a particular era, enhancing the narrative context, and visually supporting a director's vision (Nadoolman Landis 2012a). As these convincing identifiers of the period could not be established in Fiona's costume design, Mussenden designed her costume so that it would blend with the other, more period-specific features. The square neckline and gold ribbon framing the edge of the neckline match with some 14th century women's fashions. The gold embroidered pattern design on Fiona's bodice, visible in Figure 36, is another decisive detail that Mussenden chose to align with the time period but also to connect with her regal status (Mussenden 2016a, 2016c).

There is growing pressure in films to invest in protagonist characters' emotional realism to allow contemporary audiences to better relate (Brown 2021: 133). In Fiona's case, *Shrek*'s supervising animator Raman Hui remarks that the audience was more critical in their perception of her, especially Fiona in human form, which placed high expectations for the technological execution of this character (Moszkowicz 2002: 296). I argue that this kind of demand on the character, of course, also puts emphasis on her costume. As only a limited number of design choices could be linked with the period

Figure 36. The decorative pattern on Fiona's bodice and neckline was the only detail in her costume that specifically reflected the Middle Ages, circa 14th century. Screenshot (cropped) from *Shrek*.

costume design, details indicating the personality of the character were also worthwhile additions to the character. Takolander and McCooey (2005) describe Fiona's personality as 'single, beautiful, stick-figured Charlie's Angel' displayed in a traditional fairy-tale concept trapped in a tower 'awaiting her true love's first kiss.' As the story continues, the audience becomes acquainted with the true gentle nature of Princess Fiona, especially when she transforms into an ogre. Prior to ogre form, Fiona physically exhibits a strong personality, for example, in a scene where she, Shrek, and Donkey encounter Robin Hood's Merry Men. Fiona successfully battles and wins in the group of male characters. In her interview, Mussenden (2016a) explains that she chose the angular neckline on Fiona's dress to reflect the strong, determined personality of Princess Fiona. Later in the film, when the character transforms into her true form as an ogre, Mussenden (2016b) points out that the round shapes found in the dress details on the neckline, for example, correspond with the character's gentler personality, as well as the softer body figure. Mussenden's (2016a, 2016b) decision for the similar round shapes and soft forms in Fiona's costumes in *Shrek 2* reflects her body figure and personality as she mostly performs as an ogre in the film. Mussenden describes Fiona's first costume in *Shrek 2* as a 'cute little swamp dress' that does not distract from the action. Mussenden's decisions on the details in Fiona's costumes

illustrate how costume design reflects the character's personality and body shape.

A closer relationship between costume and historical time period was achieved in the male characters in *Shrek* as men's fashions in the height of the Middle Ages included less volume in clothing. Tight-fitting hose and fitted tunics with minimal flare represent designs common to the High Middle Ages in 14th century Northern Europe (see Figure 32) and are fortuitously also the kinds of designs more easily accomplished with digital animation. Hence, those garments with minimal volume and a tight fit create fewer problems with cloth collision and tend not to necessitate additional animation independent from the character movement and requiring secondary motion. Throughout the film, male characters wore similar costume styles including tunics and hose, for example, the Merry Men (Figure 37) and characters in the crowd scenes (see section 4.4). Armour was also worn, which is easier to animate than women's dresses with volume due to armour's hard surface. Armour also connects with the time period, indicating that female characters like Fiona connected less with the historical time period.

Street (2001: 23) remarks that costumes perform an authenticating role in defining the individual character, although they also relate to the intertwined stories of the other characters. This brings coherence in the overall costume design and is visible, for example, in depiction of the time period in costumes throughout a film. In the case of *Shrek*, the period fashions in the female character's costumes should therefore correspond with the same time period depicted in the male character costumes. However, in the scene where Fiona encounters the Merry Men (Figure 37), the male character costumes correspond more strongly with the 14th century than Fiona's dress. Since many of the other male characters in the film wore similar clothing as the Merry Men, the male costumes convey more substantial period references throughout the film. This example demonstrates that the visual impression relating to the 14th century in Northern Europe was conveyed through the male clothing because technological issues such as cloth and object-cloth collision limited the period signs in the female costumes. The combination of different styles in the costumes resulted in an overall costume design that blends costumes with more and fewer period-specific designs.

Figure 37. The figure illustrates one of the Merry Men characters whose costumes aligned with period fashions from the height of the Middle Ages. Screenshot from *Shrek*.

Shrek 2 continued depicting the 14th century fashions; however, similar design parameters as the previous film persisted in affecting the female characters' costume design. According to Mussenden (2016b), female fashions from the High Middle Ages in Northern Europe, such as floor-length gowns or hanging sleeves, still could not be included in the character's wardrobe due to limitations in animation software. Consequently, Fiona's dresses included tight-fitting sleeves and ankle-length hemlines, with less volume than was common in the period. Although collision issues remained in costumes containing large volumes of cloth, advancements had been achieved that produced a more authentic depiction of costumes in *Shrek 2*. DreamWorks artists developed a software that enabled the animation of the wrinkles on garments on those parts where the garment would naturally have wrinkles (Cutler et al. 2007). For example, with this method, wrinkles appear naturally when a character bends sideways or forward, especially if the character wears a tight-fitting garment. The wrinkles were added on the costume so that each character's body type had its own "wrinkle database". These were multiplied to different costumes on the same body form (Cutler et al. 2007: 225). The wrinkle database was useful when the characters had not only one distinct body type, but also when the same costume models were re-used in the film or across films. Re-using the costume structures functioned together with the multiplied wrinkles on the same costume model. This innovation in computer animation added more authenticity in costumes in *Shrek 2*, but

it failed to account for the ways that different materials behave to create different kinds of wrinkles. The weight and texture of different materials behave differently, for example, velvet creates softer and bulkier wrinkles in a garment as opposed to finer materials, such as fine silk or chiffon. Therefore, the wrinkles must be different on each different type of costume, depending on its material.

While the "wrinkle database" allows the same wrinkles to be multiplied in different garments, it does not take into consideration the fit of the garment. This is a clear example of how technological development does not fully understand nor consider real-life garment construction and materials' behaviour. Different materials function better on different garment structures, where selecting the materials is an important part of costume design development. If the garment fit and materials move and wrinkle on the body in an authentic way, they enhance the character's visual and performative believability.

An examination of the costumes in *Shrek the Third* shows that women's dresses in the film included more volume than in the previous films. Some of the female character costumes are also floor length with wide hanging sleeves. Costume designer Israel Segal (2017a) also remarks that, when he designed the costumes for the characters of *Shrek the Third*, he did not recall any of the design parameters that Mussenden experienced. In addition, *Monster House* and *Big Hero 6* were computer-animated films produced after *Shrek the Third*, and costume designers Ruth Myers (2017) and Danny Flynn (2017) did not remember facing issues in their costume design development due to limitations of technology.[46] However, according to my visual analysis, most of the costumes in the two films were tight-fitting on the body, which is a design that does not cause significant collision issues nor is it time-consuming to animate when the character moves.

To conclude, the case study films show certain effects of the computer animation medium on digital character costume design. Cloth collision with itself or other surfaces reflects costume movement and inhibits costume construction. In addition, animating secondary motion for cloth on those garments that are loose is more time-consuming than those that are tight-fitting on the body. I would argue that issues related to cloth collision and secondary motion are the reason why character costumes in computer-animated films are often designed with a minimal amount of volume in costume material and are close-fitting. Advancements in technology, such as the "wrinkle database" that created the behaviour of cloth wrinkles on the costumes multiplied to the same body form, have generated a more realistic behaviour of costumes when characters move. Each development in software contributes to costumes that look and behave more authentically.

[46] This results from Segal's, Flynn's, and Myers' oral testimonies.

4.3 The physical condition of a costume tells a narrative

In live-action filmmaking, the physical condition of costumes is a result of careful research on indicating visual signs of the character's life and their role and performance in the film's narrative. Ageing and other material manipulation for tangible garments are achieved by distressing and dyeing the cloth to achieve signs of past actions. Costumes are physically handled in a way that they respond to physical activity in a scene and in relation to a character's past activity and actions. The combination of the two, action in the scene, and the visual signs produced by ageing in costumes, increase authenticity in costume design and the scene in general (Dierker 2019: 196, 199). For example, dirt and sweat are both an outcome of a character's performance, and signs on the costume resulting from this physical activity visually convey these actions to the spectator. Sweat on a shirt creates multisensorial effects, involving feelings from air temperature or scent. The physical condition of costume invites sensory and haptic perception, which shows that the spectator connects with the characters' physical activity and achieves a deeper level of understanding of the character.

Also, in computer animation, reproducing the aged feel on digital textured surfaces improves the level of authenticity of the film. Fife Donaldson (2018: 74, 78) points out that the textural qualities in film environments include a narrative of their own where 'surface characteristics are perhaps the most immediate to communicate the feel of a fictional world: a hard rough space might seem gritty or even threatening, while smooth and soft environment can be luxurious or comforting.' She adds that the feel of different textured surfaces conveys mood and atmosphere, as well as invokes a range of sensory experiences beyond sight and sound. The fine details in texture help the spectator immerse in the world of the film. Fife Donaldson argues

that textures convey sensorial and embodied experiences for the spectator, similar to Marks' (2000) ideas that cinema appeals to senses, is powerful in conjuring multisensory experiences and that all senses are involved in cinematic viewing. As with live-action films, digital surfaces in computer-animated films are equally powerful in conjuring multisensorial experiences, explaining their attraction to a number of film theorists (Prince 1996; Fife Donaldson 1998; Barker 2009). In relation to *Toy Story*, Fife Donaldson (2018: 78) adds that 'the contrast between shiny or rough surface tells a story about prior interactions. Texture thereby adds depth, in aesthetics and narrative terms.' In such cases, 'marks and dirt add to the surface's touchability, in that there is something to feel.' On this point, the more accurate the reproduction of the aged texture is, the more it influences spectators' embodied experience of the surface textures, that is, the 'feeling' of the material. Whereas Fife Donaldson's focus is the design and representation of plastic toys, all digital surface textures, including costumes, similarly convey multisensorial effects that enable the spectator to connect with the feel of the film's world, its mood, and atmosphere. An accurate depiction of costume materials and conveying an aged look on textured surfaces adds tactility to costumes and to the "touchability". In addition, ageing on costumes creates a narrative of its own while telling a story of the characters in visual terms. Signs of ageing on digital costume surfaces also reflect changes in the narrative and the action in the scenes. The level of ageing in digital costume texture is essential for transferring these multisensorial effects for the spectator.

The level of ageing, signs of dirt, or roughness and smoothness in material textures on digital costumes differ greatly between the case study films. The most visible costume ageing that reflects signs of a character's personal life and identity in each of the *Shrek* films, in fact, occurs on Shrek's costume. Prior to Mussenden's starting the costume design on *Shrek*, visual development artists at DreamWorks had worked on the visual representation of the character. Animator Kelly Kimball (2017) contributed to the early designs of Shrek's costume, which resembled the body figure and visual style of the character seen in the illustrations in William Steig's children's book *Shrek!* (Figure 38). Kimball's illustrations show that the designs reflected Shrek's personality and living conditions in the swamp by including stains on his tunic. As discussed in the previous chapter, Shrek's body form was altered from Steig's original design; however, Shrek's costume in the final animation was influenced by these illustrations and Steig's original character design, partly because the character was already known by his visual appearance (Sito 2017).

Figure 38. Animator Kelly Kimball's costume designs for the character Shrek for the film *Shrek*. Early designs of Shrek reflect the original illustrations presented in the children's book by William Steig. Even though the character's form changed from these illustrations, the stained visual look in his costume remained the same in the film. Courtesy of Kelly Kimball.

The stains on the character's tunic, which fully represented the grumpy ogre living in a swamp, remained in the digital version of Shrek. Kimball (2017) states that she contributed to the design of his brown textured vest, and the rest of his costume design was achieved by collaboration among the other animation artists. His costume ensemble also included an off-white linen tunic that has been accurately digitally produced to resemble loosely woven, rough, and bulky yarn. If made in real life, this kind of texture frays easily. The tunic includes stains especially on the stomach area, and ageing is also achieved by creating an appearance of fraying on the tunic's sleeve cuffs and hemline. The level of ageing on Shrek's costume enhances the spectator's understanding of the character's personal life while living in the swamp and indeed adds, in Fife Donaldson's (2018) terms, "touchability" to the costume.

Such detailed creation of a distressed and aged garment worn by Shrek was not executed for the other character costumes in the first *Shrek*.

Mussenden (2016a) and Aretos (2017) both discuss the challenges regarding computer animation during the film's production, and therefore, the accuracy of texture and material finishing, such as ageing, were secondary in the digital material creation. Therefore, the development of technology did influence the level of the aged feel on costume textures in this film. Although the software was capable of producing the texture quality, the time and effort needed for such details in costume structure and material movement, especially collision effects, were prohibitive, as discussed earlier in this chapter. Consequently, nearly all costumes in *Shrek* depicted 'cleaner' textured surfaces without visual signs of ageing. In the following films, however, the development in computer animation software, such as the DreamWorks' "fabric shading model," enabled more sophisticated digital creation of material textures in *Shrek 2* and *Shrek the Third*, thereby increasing the level of depth and texture in these films. Even so, as in *Shrek*, the only aged costume in the two sequels was designed for the character Shrek. In *Shrek 2*, Mussenden (2016b) recalls focusing on details of the costume textures, but this

Figure 39 (left). Ruth Myers' costume drawing of the character Nebbercracker for the film *Monster House* shows how the costume designer wished the physical condition of the costume to be depicted in the animated film. Courtesy of Ruth Myers.
Figure 40 (right). Nebbercracker chasing after D.J. The worn and stained appearance shown in Myers' costume drawing is also digitally reproduced in Nebbercracker's costume in the final animation. Screenshot (cropped) from *Monster House.*

ability to choose a larger variety of fabric texture finishes did not evolve in the physical condition of the costumes of other characters.

The creation of clean textile surfaces brings a certain kind of visual aesthetics to the entire film, which links with a plain visual style in costumes, including very few details and material textures. Ruth Myers' (2017) costume design for *Monster House* is an example of this. She states that her design approach for the costumes and textures was to achieve a 'simplistic look,' in which details such as achieving a physical condition on the garments were minimal. However, here, simplicity is not a negative statement but a certain design style in costume design that stems from the fact that *Monster House* was an animated film and not live-action. Myers (2017) points out, 'I would have never done things as simplistically [in live-action], therefore the designs couldn't be in an ordinary film.' The execution of material textures in *Monster House* results in a combination of worn and new clothing where ageing and dirt have been used in some costumes for visual indication of character personal identity. Nebbercracker's costume has stains and indications of wear and tear that reflect on his old age, crabby personality, and his environment, living in an old, haunted house. Different textures and texture finishing are visible in Myers' costume drawing for the character (Figure 39). Comparative analysis shows that a similar aesthetic texture also appears in his costume in the animated film (Figure 40), Thus, there is an attempt to bring texture, tactility, and appearance of the character's past life to this particular costume. A similar effect is achieved in two additional characters' costumes in the film – nanny Zee and her boyfriend Bones.

According to the visual analysis, it would seem that computer animation more easily produces material surfaces with clean and plain textures than those that are rougher and have signs of ageing. This favours those characters whose personal or narrative development requires clothing that appears "new". For example, in *Shrek 2*, Prince Charming's flashy and humoristic personality and royal status are well reflected through his costume. The golden two-tone jacket of shiny sateen and gold boots emphasise Charming's flamboyant nature. The gold colour on his jacket and boots matches well with his personality and status. Mussenden (2016b) recalls showing his persona through the gold colour and rich print visible in the costume drawing in Figure 41. The costume structure, parti-colouring, and decorative, ornamental designs connect to the film's time period. In the end, the costume design was slightly altered for the animated version. The final animated film

Figures 41 and 42. Isis Mussenden's costume drawing for Prince Charming depicts gold colours that reflect his flashy personality. The appearance of shiny sateen material visually links with his personality and royal status. The original design in the drawing was slightly altered for the animation. Figure 41 courtesy of Isis Mussenden; Figure 42 screenshot (cropped) from *Shrek 2*

(Figure 42) includes the cuffs of his tunic finished with two tones, white and gold, rather than one gold tone that is visible in the drawing. This functions better in highlighting the gold pattern on the cuffs. In *Shrek 2*, the development in the "cloth wrinkle system" was specifically used in tight clothing such as Prince Charming's tunic (Cutler et al. 2007) and lent itself to a more authentic depiction of the shine on the fabric (see Figure 42). This kind of material behaviour adds to the tactile feel of the garment and results in a more a realistic material texture movement.

In contrast to the other case study films, signs of ageing are achieved across the character costumes in *Puss in Boots*. At the time of the film's production, animation software shows advancements in the accurate depiction of textures, specifically different material weaves. For example, a study by Irawan and Marchner (2012) present a "scattering model" for woven cloth 'that describes the reflectance and the texture based on an analysis of specular reflection from the fibers.' Accuracy at the level of fibre, not only the depiction of the fabric surface, increases the level of ageing on the fabric. Even though this particular study of Irawan and Marchner does not specifically refer to reproducing the appearance of cloth in *Puss in Boots*, it supports my visual analysis by indicating that this type of technological development had been accomplished at the time of the film's making. The visual analysis of the costumes in *Puss in Boots* shows a richer visual quality in costume material depiction and a larger variety of aged and worn clothing in *Puss in Boots*. Costumes show textured, almost tactile surfaces that convey a different kind of aesthetics not achieved in the previous *Shrek* films. Mussenden (2018a, 2018b) describes focusing not only on different fabric surfaces in the costumes, but also on how these surface textures were aged. Such refinements to the costumes' textures help reflect each character's story arcs and personal and narrative development. Ageing on the fabric textures can be discerned on the villainous characters Jack and Jill, which reflects their past life as robbers. Worn velvet is clearly visible on Jack's doublet shoulders, especially by the stitching line at the centre front and by the piping on the roll padding (Figure 43) that adds more tactility and the aged "feel" of the cloth in the garment. As Fife Donaldson (2018: 78) argues, 'roughened surface invites exploration and tells a story about prior interactions' where 'texture thereby in aesthetic and narrative terms,' evokes embodied experiences by perceiving the texture through vision. The aged textures add, in Fife Donaldson's terms, "touchability" and reflect the character's personal history.

The appearance of worn clothing was also achieved in the few garment pieces on Puss' character. Mussenden (2018a) explains that there was a motivation to visually uplift him, as *Puss in Boots* is a spin-off film developed

Figure 43. Worn material textures in the film *Puss in Boots* enhanced the perceptive understanding of the costume, linking the costumes better with the characters' personal story development. Screenshot from *Puss in Boots*.

from Puss' character. She describes that this was achieved by creating Puss' boots as much grander and adding more details on his costume, such as the sash around his hat. The ability to digitally create the ageing and more accurate texture finishing enriched Puss' character. His hat includes a rich feel of felted wool and his boots accurately depict distressed leather, even showing the stitching on the sole of the boot (Figure 44). These small details in material textures, such as the felt, distressed leather, and stitching, enhance the tactile feel of the costume. The changes in Puss' material textures were small considering his few costume pieces, but the richer textures strongly enhance the character's appearance. As in the case of Jack and Jill, the execution of worn leather in Puss' boots or the texture feel in his felted hat connect the character with the rest of the film's visual style.

The depiction of worn clothing textures that support narrative development and actions in scenes is only visible in Shrek's costume in *Shrek*. When Shrek rescues Fiona from a tower, they escape from the dragon's fire and travel a long journey to Lord Farquaad's castle. Stains and dust from these actions are visible only in Shrek's costume. In the same scenes and actions, Fiona's green dress surface does not accumulate signs of wear and dirt, and it appears as 'new' throughout the course of the film. Wearing the same dress during almost the entire film would be expected to cause some sort of

Figure 44. Worn leather finishing and stitching in the sole of the boots are examples of the ways costumes in *Puss in Boots* create a better tactile connection on the costume. Screenshot from *Puss in Boots*.

visible wear in real life. Signs of dirt on Fiona's costume would have reflected the narrative development and the passage of time, especially during her travel with Shrek and Donkey. An improved level of realism in the ageing of Fiona's costume would, in fact, connect the character better with the narrative development and action in the scenes. The technology seemed to be available for this kind of detail as stains appear on Shrek's costume; however, it has not been employed on Fiona's dress.

A closer examination of the costumes in the other case study films shows that ageing is not employed in the costume textures to support the narrative development and reflect action in scenes. Even though technology and animation software had developed, for example, in *Big Hero 6*, which was produced much later than the *Shrek* films, very few signs of ageing that visually indicate the film's narrative development are visible. One clear example appears in a scene where the lead character Hiro and his brother Tadashi experience an explosion, in which Tadashi tragically dies. Due to the force of air from the explosion, Hiro lies on the ground, and the flames from the explosion are visible in his background (Figure 45). Even after this dramatic event, Hiro's costume remains "untouched", without any signs of the explosion or his physical fall to the ground (Figure 46). Some kind of wear and dirt on his costume would reflect the physical event caused by the explosion and the emotional effects produced by the loss of his brother Tadashi. These "clean" material textures without any visual signs of dirt fail to support the events in the narrative and therefore seem less realistic. The decision to neglect visual signs of physical activity is either deliberately side-lining the importance of such detail or following an aesthetic design that omits this kind of detail. These clean textured surfaces indeed create a certain kind of aesthetic design in the film that unfortunately disconnects the characters from the narrative in this type of action.

My analyses in this section have demonstrated that the physical condition of the garment is mostly absent from digital character costume textures in the case study films. As a result, most of the costumes in each film have clear, clean, and unworn texture finishing. This kind of texture effect favours characters whose personal visual identification requires that kind of texture on their costumes to support character identity. The pristine and non-aged look functions well in depicting the royal characters' clothing, such as Princess Fiona and Prince Charming. Ageing in clothing would have better conveyed the characters' past lived experiences and indicated the difference

Figure 45. Hiro lies on the ground due to the force from the explosion. Screenshot (cropped) from *Big Hero 6*.

Figure 46. Close shot of Hiro shows that the explosion and physical action do not cause any dirt on his clothing. Screenshot (cropped) from *Big Hero 6*.

between the character's personalities and statuses. My analysis also shows a lack of visual indications of physical wear on the costumes reflecting physical activity in scenes.

Even though the development of computer animation software, such as the DreamWorks' "fabric shading model" (Glumac and Doepp 2004) and the "wrinkle database" (Cutler et al. 2007) enabled authentic ageing on costumes, especially in *Shrek 2* and *Shrek the Third*, these films did not employ indication of physical wear in the costume textures to enrich the characters' connection with the narrative. *Monster House* and *Big Hero 6* similarly include costumes that are executed in a way that the physical condition of those costumes does not reflect the character's past life or the narrative development in the films. Consequently, these films attain a similar design style in costumes that depicts certain visual aesthetics. In contrast, the accurate ageing in the costumes in *Puss in Boots* achieves tactility in the costumes, making them perceptually realistic by depicting more accurate real-world materials. These indicators affect the multisensorial effect of perception and the ways spectators perceive the costumes through vision, following on Marks' (2000, 2002) idea of the multisensory quality of perception in which vision is unified with bodily experiences such as touch and feel. What we see is felt in the body. According to this phenomenological engagement with digital costumes, spectators are able to feel different costume material qualities, such as softness or roughness through vision. For this reason, ageing is also important in digital costumes for visually conveying signs of the character's past life and their connection with the action in scenes.

4.4 The same, but different: Costume design for the crowds

The previous sections have focused on the design and style of the computer-generated lead character costumes. This section shifts the focus to crowds, as most films, animation, and live-action, include "generic characters" who perform as "extras" and are important in strengthening the action in the scenes. For example, a party scene would not be the same without a large number of guests, or when a lead character gives a speech, it would not be the same without the audience. Scenes with crowds, including hundreds or even thousands of extras, create a strong visual impact in the storytelling. Costumes worn by these extra characters have significant visual function; they are cohesive with the backgrounds and provide support for the costumes of the lead characters (Hollander 1993: 238). Costume design for the extras links with the aesthetic design style indicated in the art direction, as not only the lead characters' costumes contribute to the overall visual aesthetics of the film. In computer-animated films, the extras are commonly referred to as generic characters. Based on the interviews, as well as analysing the designers' costume drawings and the final outcome of the generic character costumes in the case study films, there appears to be a specific approach to designing costumes for these digital generic characters in the crowd scenes.

Film productions have benefitted from the development of CGI, as these new technologies enable multiplying a large number of generic characters for more expansive crowd scenes. Due to the development of sophisticated crowd-generating software, there is no need to film an army of physical actors performing as extras in crowd scenes. Instead, a small number of actors can be either multiplied or entirely digitally created to achieve an army of 10,000 people, including their costumes (Sito 2017). Due to this form of image processing, on those occasions when the narrative development requires crowds in the environments, computer-animated films can be populated with 'strikingly large casts' (Holliday 2018: 78). Whissel (2010) calls these hundreds of thousands of digital beings as "digital multitudes," which are powerful in depicting the relationship between individual characters and the crowds. The crowds often are meant to go relatively unnoticed; however, the digital crowds are indeed important in the collective action (Whissel 2010: 92).

The animation industry uses different crowd simulation programs to easily design, multiply, and create the crowd characters' performance. For example, the Denizen programme created a diverse, vast population in the city of San Fransokyo in *Big Hero 6*, whereas the Presto software was used to generate the minion worlds in *Despicable Me 2* (Coffin and Renaud 2013) (Hamed et al. 2015). The simulation programs are also used in parallel with software that creates the characters. In the case of Pixar's *Wall-E*, the individual generic characters in the crowd were created with RenderMan, a software used in the creation of characters and environments, whereas the crowd's animation was built with MASSIVE (Multiple Agent Simulation System in Virtual Environment) (Holliday 2018; Planck and Bugaj 2008). Furthermore, one program can be used in different films and even between different kinds of characters, such as humans and animals. PDI/DreamWorks' "proprietary mob system" was used to create the crowds in the first two *Shrek* films, and the technology was further developed for the animal worlds in *Madagascar* (McGrath and Darnell 2005). DreamWorks' Dynamic Crowd Characters System and High-Level Behaviors software increased the level of believability in the crowd characters, who react in action in the scenes. The digital extras are treated with equal importance as real extras would in crowd scenes (Kermel 2005).

The different body shapes on digitally created characters create an illusion of a variety of people in the crowd in DreamWorks films, and in computer animation in general (Cutler et al. 2007). On this point, Mussenden (2016c) adds that the creation of different body shapes, face, and hair features for the generics was equivalent to casting different looking actors for a film. Thus, the crowd scenes can present a variety of visually different people, in their height, weight, and shape. Mussenden (2016c) continues that the generic characters are like a 'skyline of a city' and that 'if every building were six feet tall and exactly the same, it's not interesting. If you have one building here ... and little round there, it just looks kind of interesting for the overall silhouette.' Costume design follows the same variation to achieve a versatile visual look for the crowd. Solomon (2013: 79-80) explains that in Disney's *Frozen*, the colour scheme was also important in the design of the generic characters, as it blends those large varieties of shapes and forms, linking the crowds with the environments. A film perpetuating this certain subtle colour range on the generic characters draws more attention to the lead roles with stronger colour choices. Mussenden (2016c) points out that the generic characters' costumes either match or contrast with the lead characters and connect with the visual aesthetics of the film. Based on this, in order for the generic characters to be interesting, realistic, and believable, there should exist variety not only in the body forms but also in the colouring, texture, and silhouette in the character costumes, which in fact create the versatility for the crowds.

Variety in costumes is designed for the generic characters similar to how costumes are based on the pre-designed generic body forms. Mussenden (2018b) explains that the film's period and visual aesthetics that are indicated in the art direction influence the generic character costume design. She created preliminary ideas as rough sketches based on characters' body types, as well as the film's period and location. Figure 47 is an example of Mussenden's sketch of costume drawing from an early stage of developing the generic characters' costumes, which illustrates costume ideas for the little orphans in the film *Puss in Boots*.

Mussenden (2016c) and Segal (2017a) explain that the different body types pre-designed by the production company are identified with either a number or letter indication (1, 2, 3... or A, B, C...). These different bodies are the "characters" for which the costumes are designed. The bodies are multiplied to create an illusion of a larger crowd. The costume design differs from those of the lead characters as the costume ensembles for the different body shapes are broken down into individual garment pieces. A variety of

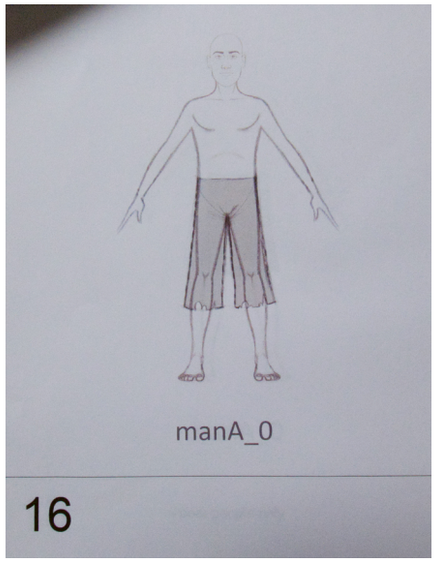
Figure 47. Isis Mussenden's costume sketch for the little orphans who performed as generic characters in *Puss in Boots*. Courtesy of Isis Mussenden.

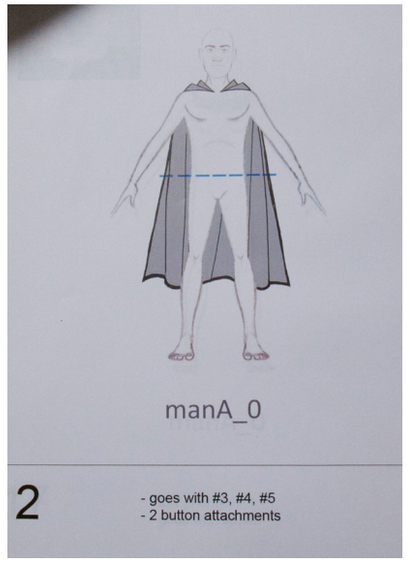
tops, bottoms, shoes, and accessories for both male and female characters are each numbered or labelled and individually drawn on a generic character's body. Figures 48, 49, and 50 provide examples of the different garment choices for the generic characters in the production of *Puss in Boots*. These visual examples illustrate how the garment pieces are indicated with number codes, where each body type and garment piece have their own codes. Mussenden (2018b) explains that even the smallest accessory such as a scarf on a head should be drawn (Figure 50), as 'this is how they needed to see it,' referring to the animators who create the garments on the generic characters for the crowd scenes. Each garment has to be visualised, including all those details that are part of the garment and the way the designer wishes

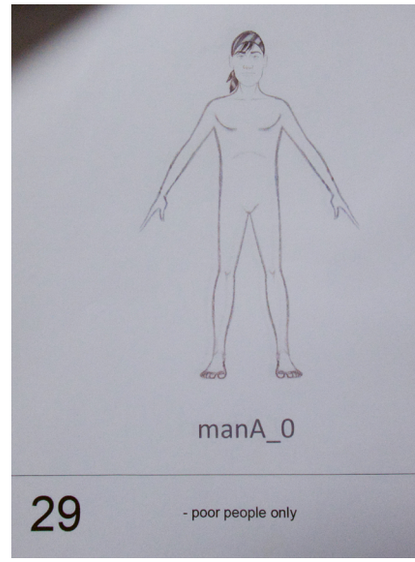
it to be worn on a body. Information regarding the garment is then passed onto many animators who digitally create the costume as well as animate the character's performance during a phase when costume designers are no longer engaged in the production. On this point, Mussenden (2018b) also describes that 'they're creating it from nothing,' meaning that everything in computer animation is created pixel by pixel, the speed and quality of which are influenced by the animation software development. Clear and informative designs enable an easier animation process and satisfying end result.

Different garments and accessories are designed so that they can be re-used on the same body types. In addition, they are designed to be "worn" with each other, meaning that different tops, bottoms, and accessories can be, as Segal (2017a) described, 'mixed and matched,' creating the illusion of multiple costume ensembles. Consequently, the variation in different costume ensembles for the generic characters is achieved by combining a set of garments together, at the same time creating more extensive variety in the generic characters. The number or letter code given for each body type, garment, or accessory aids in the indication or categorisation of all the garment pieces and accessories used in the costume (Mussenden 2016c, Segal 2017a).

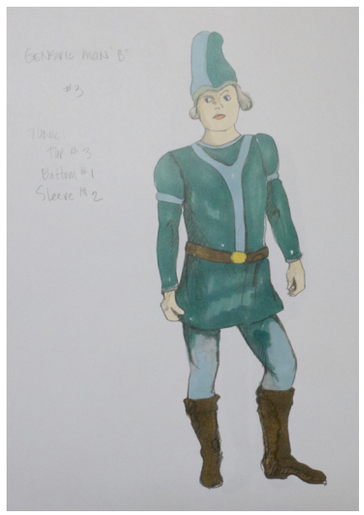
Figures 48, 49, and 50. Examples of garment pieces on generic characters in *Puss in Boots*. These computer-generated models were created after Isis Mussenden designed a variety of different garments and costume ensembles. Courtesy of Isis Mussenden.

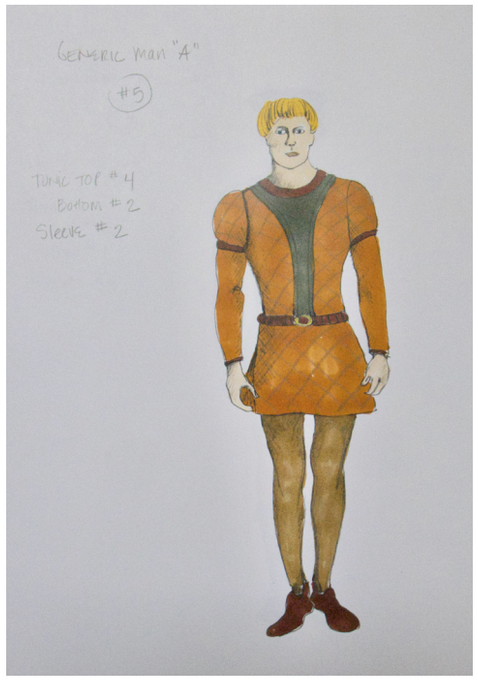






The costume designer provides examples of how the garment pieces can be assembled to produce variation for the costume ensembles. Figure 51 illustrates Mussenden's design for *Shrek 2*, in which the costume ensemble for a generic man "A" consists of a number 2 top, number 1 bottom, and number 4 sleeve. Another variation is shown in Figure 52 for the same generic man "A". This costume ensemble comprises a number 4 top, number 2 bottom, and number 2 sleeve. Figure 53 includes an example of a costume ensemble for the generic man "B". Even though the costume designer suggests the different ways these garment pieces are combined, Mussenden (2016c) explains





Figures 51, 52, and 53. Isis Mussenden's costume designs for the generic characters in *Shrek 2*. The drawings demonstrate how the different garment pieces were combined to create a costume ensemble. The drawings indicate the different number codes for each garment. Courtesy of Isis Mussenden.

that the production designer oversaw the design of the generic character costumes, as the creation of crowd scenes often occurs after the costume designer has completed their work in the production. Crowds contribute to the overall composition of scenes, which corresponds with the production designer's responsibilities in a film. None of the costume designers interviewed for this thesis reported being contacted for additional advice on generic character costumes after they departed the production. Therefore, the costume designers' original designs for generic characters are critical and must include multiple garment combinations, as well as accurately aligning with time period, colour range, and the visual aesthetics of the film.

The complexity of the garments on generic characters appears not to be impacted as strongly by the development of technology across the case study films. As with costumes on lead characters, each garment is first constructed as a digital costume model and multiplied on several characters. The development in computer animation has influenced the digital production of costume surface textures by enabling the depiction of more three-dimensional cloth surfaces. This brings richness to costumes as a variety of material surfaces can also be used on the generic character costumes. Together these details in the fabric surface enhance the tactility in costumes and consequently increase the spectator's perceptive understanding of the costumes and connection with the characters and the world of the film.

Including a large number of generic characters in crowd scenes adds a powerful visual appearance and diversity in the crowd, which can further enhance the representation of the period or location in a film. For instance, the two crowd scenes in *Shrek* furthered the depiction of the 14th century, despite some challenges in achieving the same period fashion as Fiona's costume. The crowd characters' costumes more accurately portrayed the period of the High Middle Ages, especially their silhouettes and accessories such as tall headdresses on female characters (see Figure 32). These two crowd scenes from *Shrek* present an example of a simple way that costume ensembles can be multiplied on generic characters. In fact, only two costume models appear to be used for the male tunics, which are re-used in all of the male characters' costume ensembles. However, an illusion of a different costume design is crafted, in a similar fashion to the lead characters' costumes changing with only a simple colour change in the tunics. This technique is also visible in the tournament crowd scene in an earlier part of *Shrek* (Figure 54).

Figure 54. Generic characters in a crowd scene in *Shrek*. The costumes are built from the same costume models, multiplied on each character. The male tunics are created from two different costume models. Screenshot from *Shrek*.

Figure 55. The same male tunic model on the generic characters is used in the crowd scene at the end of the film *Shrek*. Screenshot from *Shrek*.

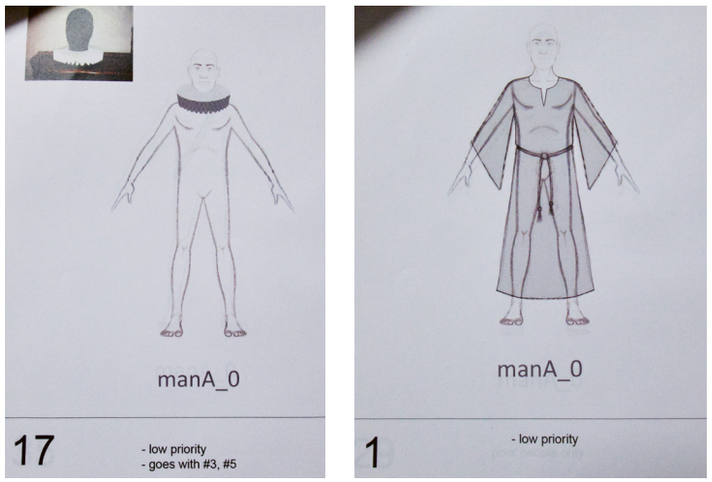
The male costumes for the film's crowd scenes are the same tunic design reused at the end of the film in the wedding scene (Figure 55).

The visual appearance of a large number of generic characters enhances the connection with the film's locations as exemplified by Mussenden's generic character costume designs for *Puss in Boots*. The costume ensembles of the two women show the difference in colour and structure, which are designed either for the scenes in the city or country. Mussenden explained that they represented 'more of a town look' (Mussenden 2018b) (Figure 56) and in contrast, peasants in the countryside (Figure 57). Costumes on the generics in the city contain more period costume-related details, vibrant colours, and elaborate materials such as velvet and sateen as opposed to the peasants whose costumes possess earthy tones and materials. Once these designs are multiplied in a crowd, the visual appearance generates a more convincing image of the specific location, whether town or countryside. Additionally, as in each of the case study films, the generic character costumes also align with the films' time period, that is, the Renaissance era circa 16th century.

Figures 56 and 57. Isis Mussenden's generic character costume designs for *Puss in Boots* show that generic characters can enhance the visual connection with the location and time. Courtesy of Isis Mussenden.

Advances in computer animation software clearly affected the design of generic character costumes over time. The visual analysis shows that the crowd scenes in *Shrek* presented costumes with very little detail, whereas in *Shrek 2*, more variety appears in the material textures, prints, and garment constructions on the generic character costumes, as with the lead characters. Mussenden (2016b) recalls that the difference in costume design for generic characters between these two films lay in the capacity to design more diverse costume structures and textures in *Shrek 2*. These advancements permitted such accomplishments as the "fabric shading model" (Glumac and Doepp 2004) and "wrinkle database" (Cutler et al. 2007). The developments in computer animation were also responsible for a larger number of generic characters in *Shrek 2* than in the previous film. Mussenden also noted how the styles of the generic character costumes differed from the previous film. Thus, as with *Shrek*, the designs in *Shrek 2* were re-used, and the change in colour repetition and print designs generated new costume ensembles. The large crowds of generic characters in each *Shrek* film wearing clothing alluding to the Middle Ages made for powerful visual images evoking both time and place.

Developments in technology have shaped the creation of generic character costumes that include a lot of volume, even though there is less movement involved in the generic character's performance. As with the lead character costumes, issues with self-collision, object-cloth collision, and secondary motion also occur in generic character costumes. As discussed earlier in this chapter, tight-fitting garments with minimal flare and drape are much faster to animate due to fewer collision problems. In contrast, wide hems and sleeves cause more collision issues and must be animated separately from the body, which adds secondary movement to characters' primary movement. Such features are more time-consuming and complex to animate. Consequently, costumes with volume or complicated structures tend not to be chosen for generic character costumes. For example, some of the designs for generic characters in *Puss in Boots* have an indication of "low priority". Each garment example with this indication either has a complicated structure (Figure 58) or has a lot of volume in the garment (Figure 59). Due to collision issues and secondary motion, most generic characters' costumes are either fitted to the body or have little volume.



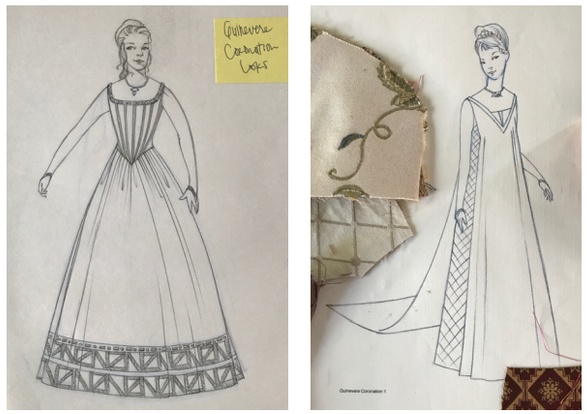
Figures 58 and 59. These particular garments are time-consuming to create with computer animation and are therefore examples of the generic character costumes that have "low priority". Courtesy of Isis Mussenden.

Figure 60. A crowd scene shows the variety of body types and costumes for the generic characters in *Big Hero 6*. Screenshot from *Big Hero 6*.

In contrast to the costume designer's contribution in the generic character costume design in the *Shrek* films, the characters in *Big Hero 6* crowd scenes were designed by visual development artists instead of Flynn (Flynn 2020; Hamed et al. 2015). This is comparable to those computer-animated productions that do not include a professional costume designer in the filmmaking. The Denizen program that Disney used for the crowd character simulation includes a "clothing library", from which different artists could select garments for the generic characters they created (Hamed et al. 2015). Using Denizen enabled creation of a larger variety in the generic characters' body forms and clothing styles, visible in Figure 60.

The Denizen clothing library allowed for an array of garments and accessories on generic characters not unlike the numerous designs by Mussenden and Segal for their films. The key difference is that garments already included in the Denizen clothing library can be re-used on multiple characters. However, choosing garment pieces from a clothing library essentially devalues costume design. In this method, all costumes could be pulled from this library without a professional costume designers' expertise. Costume designers' tailored contributions enhance characters' storytelling value. In the *Shrek* film franchise, Mussenden and Segal ensured a coherent visual style of all costumes for both principal and generic characters.

To sum up, the digital creation of the generic character costumes in computer-animated films occurs in a similar manner to those of the lead characters, with garments designed as costume models and re-used for several supporting characters. The design of one garment is used numerous times on different generic characters with the same body form, with only a slight alteration to colour and texture. Combining different garments enhances the representation of a "new" costume ensemble. Computer animation enables a few costume designs to be multiplied into crowds of hundreds of individuals. Advancements in computer animation software facilitated richer textures on the generic and lead character costumes, adding both texture and depth. Together these details in fabric surface enhance the tactility in costumes, and consequently, increase the spectator's perceptive understanding and connection with the characters and the film.



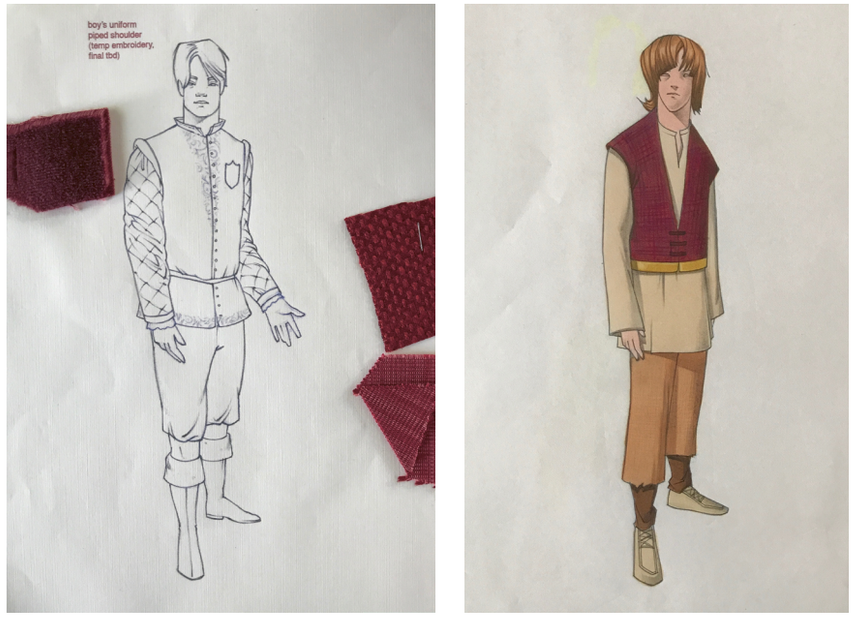
Figures 61–64. Israel Segal's costume design suggestions for the character Guinevere, prior to the decision of demoting her to one of the generic characters. Courtesy of Israel Segal.

As with the lead characters, generic characters are key visual connectors with the narrative. The previous chapter discussed costume designers' collaboration and presented the influence of continuous script development, common in computer-animated filmmaking, on digital character costume design. Changes in the narrative not only shaped the design of the lead characters' costumes but also the generics. This is evident in Israel Segal's costume design development in *Shrek the Third*. In the film, the character Guinevere was first planned as one of the lead characters. Segal (2017a) designed several costume variations for this character, developing the designs according to the collaborative production meetings (Figures

Figure 65. The importance of the character Guinevere (front left) changed during the script-writing process, and she ended up wearing the same costume as all the generic characters in this scene. Screenshot from *Shrek the Third*.

61–64). However, by the time the script was finished, Guinevere held only a small part in the film as one of the generic characters. This type of shift affects the costume design, as the original lead character designs are replaced with the generic costume. In the case of Guinevere, she was relegated to wearing the same uniform as the other high school students in the same scene, shown in Figure 65.

Another example from *Shrek the Third* shows the effect of generic characters on the design of the lead character's costumes. Segal's initial intention was to dress the lead character Artie in a costume that reflected his personality and the historical time period of the *Shrek* franchise, which was defined as circa 14th century in Northern Europe. However, the story progressed so that he is introduced as one of the students in a high school. All students are designed as generic characters and each wears a school uniform, including Guinevere. Even as a lead character, Artie is therefore required to wear the same costume as the generic characters. The school uniform for Artie and the generic characters is fashioned from a combination of Segal's two costume designs for Artie, visible in Figures 66 and 67. The diamond shape in the padding on the sleeves, the tunic, and the combination of a doublet and waistcoat are elements drawn from costume design options for Artie and included in the final design of his high school uniform costume in the film (Figure 68). Segal's designs and those eventually used in the film differed only in the tighter hose worn by the characters. The looser garments were likely too time-consuming to animate (due to collision and secondary motion) and to duplicate for so many of the other students, the generic characters, in the school.



Figures 66 and 67. Segal's costume design options for the character Artie in *Shrek the Third* were used as inspirations for the costumes on the high school boys. These were generic characters who acted in the same scene where Artie is first introduced to the spectators. Courtesy of Israel Segal.

Figure 68. The lead character Artie is introduced in the film as one of the generic characters. Therefore, his costume design matches with the generics, and he does not have his personal costume design style. Screenshot from *Shrek the Third*.

The changes in the narrative influence costume design, be it a lead or generic character in a crowd scene. The crowds and leads must all respond to one another, which creates an essential role for the generic character costumes. In the case of *Shrek the Third*, one of the characters in the generic scenes is also the lead character (Artie), and vice versa, one of the leads becomes generic (Guinevere). In addition to matching the design of the other generics in the crowd, Artie's and Guinevere's costumes also combine several other aspects, such as indicating the time period and the location. In addition, Artie's costume must also indicate signs of the character's persona because he is a lead character. Thus, digital character costume design is dependent on multiple aspects throughout the design development. As with the lead characters, generic characters' costume design performs as a visual

storyteller, reflecting the changes in scenes. Although the vast number of characters in the crowd often causes individual generic characters to go unnoticed, the generic characters together powerfully represent visual clues of time period, colour scheme, and the film's aesthetic design.

4.5 Conclusion

As my analysis and examples in this chapter clearly demonstrate, digital character costume design is a complex technological process, including both compromises and innovative ideas. A cross-examination of my case study films reveals the creation of costumes as specific costume models, re-used in and across films. The impression of an actual costume change was crafted with diverse colours, prints, and textures. Each case study film demonstrates that costume changes were executed by re-using costume structures. New software developments facilitated the construction of stronger differences between the costumes with diverse textures and colours. Between the release years of 2001 and 2014, the case study films showed more detailed and sophisticated costume textures and complicated costume structures, visible in the principal characters' costumes and generic characters in the crowd scenes.

Visual signs such as colour, texture, and ageing convey clues to a character's past life and personality. These features relate to sensory perception and the audience's understanding of the character and experience of the film. Any advancement in computer animation software results in a more accurate depiction of the costumes' textures, which then ties better to the narrative. When characters connect with the film's time period, backgrounds, and scenes, storytelling then takes place on many levels – in costume surfaces as well as in the environments.

The following chapter moves the discussion from technology to tangible materials and digitality. Where in this chapter, I discussed animation software's role in creating the character costume models and costume surfaces, in the next chapter, I explore the inclusion of tangible materials in costume design development as well as in the creation of costume material textures.

CHAPTER 5

CHAPTER 5

FROM TANGIBLE MATERIALS TO DIGITAL COSTUMES

As the last empirical part of the study, this chapter continues the discussion on the relationship between tangibility and digital materiality. Digital characters' costumes, despite their development and creation with animation software, also heavily involve the exploration of tangible, real-world materials. This aspect of costume creation emerged from the costume designers' interviews where tangible material exploration was a process that was implemented in each designers' work in computer-animated films. Digital materiality in the context of this research refers to digital characters' costumes and considers multiple levels, such as the form and construction of digital costume and the weight and texture of the fabric. These features are part of real-life tangible material properties and physical garments and also connect within the design and creation processes of digital character costumes.

The creation of digital form and construction of a costume, alongside the representation of its material weight and texture, requires tangible material references to understand how these different aspects of physical materialities can be reproduced authentically with animation software in the digital world. This fundamental relationship between the material and the digital is discussed further by Heather Holian (2018: 62) in reference to the first computer-animated film *Toy Story*. Holian remarks that the art team

of *Toy Story* benefitted from real-life references, such as concrete, tangible toys, which were employed in the design development and digital creation of the toy characters. In other animated films, exploration of tangible materials facilitated immersion into, for example, the specific Nordic and Polynesian culture and aesthetics of the Disney films *Frozen* and *Moana* (Clements and Musker 2016), respectively (Solomon 2013; Julius & Malone 2016).[47] Solomon (2013: 73, 138) explains that in *Frozen*, tangible materials provided references for the accurate depiction of details in costumes and clothing textures. As a result, the spectator can recognise details, such as the style of top stitching in the costumes in close-up shots. These tactile material characteristics are, in fact, transformed into digital surface textures, transferring behaviours of physical cloth to the digital costume. The studios appear to emphasise physical material elements in computer-animated film productions in order to create digital perceptually authentic costumes.

The digital textures that replicate tangible material surfaces in computer-animated films establish a perceptual impression of certain material textures. Jennifer Barker (2009: 46) remarks that digital media, such as computer animation, also includes tactility, 'though the forms of their tactility may be different from those of film.' Computer-animated films are equally tactile, even though their presentation is achieved digitally. Stephen Prince's (1998: 32) writing on "perceptual realism" argues that '[a] perceptually realistic image is one which structurally corresponds to the viewer's audiovisual experience of three-dimensional space,' which is presented as a set of 'cues which organise the display of light, colour, texture, movement, and sound in ways that correspond with the viewer's own understanding of these phenomena in daily life.' The production of texture, light, and shadow together creates the 'convincing photographic realities because of the complex sets of perceptual correspondences that have been built into these [digital] images' (Prince 1998: 32). Consequently, the digital textures offer the visual appeal that the spectator perceives and create their connection with the characters and the world of the film. In fact, the digital environments present 'perceptual cues about surface texture, reflectance, coloration, motion and distance, which all are powerful means in representation of digital image' (Prince 1998: 32). As the digitally realistic environments include characters and costumes, spectators' perceptual understanding of the digitally animated costumes relies on the digitally reproduced qualities of real life, such as texture, light, and shadow. The aim of the digital environments, visible in the case study films, is to recreate realistic versions of their real-life examples.

The perceptual understanding of the digital world includes the production of surface textures. Fife Donaldson (2018: 82) remarks in the context of *Toy Story* that the professionals in the visual effects team at Pixar worked with shader programs that focused on surface texture and materiality. They built those many complex layers of material texture, as discussed in the previous chapter (Section 4.3) with the aim of creating "touchability," a certain feel and tactility in the digital textures. Consequently, building textures that depict a particular aesthetic design surely correlates to the design and digital creation of digital character costumes. Tangible material references clearly assist the work of those many animation professionals in the visual effects teams who create digital costume surfaces. However, art director and production designer Guillaume Aretos (2017) remarks that the technical professionals who build the digital costumes within the context of computer-animated films are not necessarily skilled in pattern cutting, sewing, or hold such knowledge on materials in the same way as costume designers. As a result, they often have queries about the construction of digital costumes. In this sense, tangible materials also function as a visual and tactile collaborative tool clarifying the different ways that digital costumes are created. Aretos (2017) describes that during his work in DreamWorks animations such as the *Shrek* franchise, the visual effects team also posed questions regarding the costume's surface materials, such as 'do you have a microfur on the fabric, how big is the embroidery, or how do you embroider a stone in a dress... they want to know everything about it because everything has to be remade.' In order to be *remade* digitally, tangible material references inform the re-creation of the costume's material qualities, such as textures and thickness. Material examination assists in the digital reproduction of the cloth and surface texture.

In the first section of this chapter, I will explore the different ways that the costume designers employ visual materials and tangible real-world references, such as three-dimensional material samples, in digital characters' costume design development in the case study films. I draw examples particularly from Mussenden's work in *Puss in Boots* and Flynn's design development in *Big Hero 6*. The second section focuses on garment patterns that operate as another type of tangible reference material in digitally animated

[47] *Frozen* followed the landscape and environments from Norway, whereas *Moana* depicted the culture of Polynesian islands.

costume development. My interviews with the costume designers showed that digital garment creation is based on how garments are constructed in real life. Even though each costume designer's work process included real-world pattern references, I primarily draw my examples from the production of *Shrek 2*. This specific case has visual material evidence to demonstrate how different elements from patterns were transferred onto the digitally animated costumes. The following section includes a broader discussion on how motion studies – an industrial process whereby animators examine a moving person – are also included in digital character costume development and are vital to the role played by materiality within digital costume construction. The last section focuses on digitally animated costumes' final result, which is the "truthful" depiction of costume texture perceived as realistic. The evidence gleaned from the interviews reveals that tangible materials are essential references in each of the case study films. Thus, my analysis uses *Monster House* and *Shrek 2* to demonstrate that physical material referencing for accurate reproduction of material textures is part of digital character costume creation.

Throughout my analysis in this chapter, I emphasise the multisensory quality of perception and look at how visual perception of digital images can also produce other sensorial effects such as tactile and somatic experiences. For example, when confronted with computer-animated film textures, the viewer feels costume material qualities through their own experience of embodying similar material textures without physically touching them. In the first and second sections of the chapter, I mainly focus on the perception of the designer. Whereas in the fourth section, I discuss the concept of sensory perception in relation to the maker of the digitally animated costumes as part of the production of digital textures in animation, and the spectator who views the final costume in the computer-animated film. In addition to the concepts of sensory perception, embodiment, and materiality, this chapter also discusses the theory of somaesthetics (which also connects to sensory perception), which I specifically apply in relation to tangible material exploration. I use the term "soma" following Shusterman's idea that soma includes aspects of a sentient lived body and embodiment, whereas the term "body" refers merely to the figure of body and flesh (see Shusterman 2012: 5). Approaching the topic of this research through Shusterman's understanding of "soma" yields more details about the designer's own somatic experience of touching different materials in the development of costume designs. Further, I discuss the concepts of sensory perception (Shusterman 2012; Marks 2000; Barker 2009) and haptic visuality (Marks 2002) to analyse sensorial aspects of perception, such as the designer's selecting visual references in costume design development and the ways that perceiving visual references are informative in how materials feel. I view the data also from the perspective of materiality, especially the connection between tangible material textures and the digital reproduction of those textures. The aim of this chapter is to consider these concepts in relation to the role of tangible materials in the production and perception of digitally animated costumes.

5.1 Tangible and visual materials as part of costume design development

Tangible and visual materials are part of a digital character's costume design development, a phase in which the costume designers explore ideas for character costumes to reflect a character's personality, action in scenes, narrative progression, and film's aesthetic design. Involving tangible and visual materials is an important aspect making up a large part of the costume designer's design process in the case study films. Each costume designer interviewed for this thesis explained that tangible and visual material references functioned as an inspiration to develop the digital character costumes and to immerse themselves in the world of computer-animated film. The costume designers' visual materials consisted of images in historical or contemporary books and journals, and photographs taken from paintings and sculptures in museums, whereas tangible materials comprised fabrics and other tactile materials. These visual and tangible materials assisted the costume designers to select specific elements, such as texture patterns, embroidery, or trimmings, which were then transformed into ideas for costume materials and finer details.[48] Tangible and visual references seemed to be especially useful for finding inspirations that were connected to the period and location of the computer-animated film. Regarding the topic of period costume design, this section provides further information to Chapter 4, in which I discussed

[48] A similar process was adopted by costume designer Margaret Meyer while working on stop-motion animation *Coraline*. Meyer experimented with different fabrics and photocopied images of garments as reference points for character costumes (Boumaroun 2018).

how specific developments in technology supported period costume design elements in digitally animated costumes. Here, I continue the discussion on different visual and tangible material properties in the quest to find costume materials that visually convey the identity of the character.

The important role of tangible and visual references can be appreciated through the work of costume design development in the frame of live-action films. Several distinguished film costume designers, such as James Acheson, Milena Canonero, Eiko Ishioka, and Jeffrey Kurland, agree that visual and tangible materials are vital for understanding the world of the film and seeking particular references for the characters' costumes (Nadoolman Landis 2003). Nadoolman Landis (2003: 26) explains that during Canonero's costume design process, she dove into the era of the films by collecting books, photographs, paintings, and materials for inspiration, as '[y]ou never know what will generate a great idea.' Nadoolman Landis (2003: 14) adds that Acheson finds correct materials to be a critical part of costume design, which requires you to 'throw yourself into the research and find the essence of the world you are designing.' The designers' approach to costume in live-action filming is similar to their investigation of visual and tangible references for digital character costume design, even though the costumes are not sewn and constructed as in the real world but are instead produced with sophisticated digital technologies. Although the physical materials are transformed into digital surface textures during the animation process, costume design development requires a similar immersion to the world of the film as in live-action filmmaking. I propose that the experimentation of real-world material references in animation links with Tim Ingold's (2017: 102) ideas that all surfaces have a distinctive texture and that 'texture tells not only the form of things but of their substantive composition.' Therefore, recognising the object's texture enables us to understand the properties of the perceived object. According to this, tangible materials are comprehended through their distinct textural qualities, and in the context of this research, tangible materials become essential reference points for the exploration of digitally animated costume material.

The roles that visual images and tangible materials play in digital character costume design are evident, for example, in Isis Mussenden's costume design development for the DreamWorks feature *Puss in Boots*. The film is set in the early Renaissance time period in an imaginary Spanish town.[49] For this reason, Mussenden (2018b) searched for visual references of the colour scheme, garment silhouettes, and details such as embroidery that were used in the Spanish region during that specific era. The wide variety of these visual materials aided Mussenden's costume design and were transferred, for example, as a certain colour range that can be associated culturally and geographically to the specific location and time period of the film. This enabled her to link the costume design with the context of the film's art direction, with colours, visual details, and costume silhouettes that all contributed to establishing the film's Renaissance-era setting.

The exploration of visual references demonstrates how non-costume-related images can be part of the digital character's costume design development. Mussenden (2018b) found it necessary to seek references for the correct colour range that visually defines the Spanish culture, taking care not to confuse this with Mexican or Latin American culture commonly represented in the USA. Hence, Mussenden explored historical tiles and mosaics (Figures 69 and 70), giving concrete physical references that provided visual information of the pattern and colours of the location during the film's Renaissance period. These visual references do not represent clothing designs or patterns, but they provide ideas and inspiration that can be interpreted and transferred into the textiles, colours, and costume's silhouette to evoke the historical period in which the film is set. The ochre hues with indigo blue and green in the tiles and mosaics present colour tones that can then be linked to the Spanish region and therefore enable a stronger visual connection with the film's location and cultural context.

The costume designers' examination of these visual references as part of costume design development in computer-animated films can be identified as a somaesthetic experience that specifically connects with the concepts of sensory and haptic perception, because vision generates other sensorial experiences. This follows on Shusterman's (2012: x) idea that experiencing art always involves our bodily senses, in which perception creates multisensory emotions that are felt in the soma. Shusterman (2012: 3) argues that the soma is at the core of perception, where aspects such as consciousness and feelings are embodied. Here, 'soma' refers to the costume designer's

[49] As discussed in Chapter 3, each film has its own particular art direction that informs the film's aesthetic style. This can suggest quite strong restyling of the original versions of time periods and locations.

Figures 69 and 70. Examples of Isis Mussenden's visual exploration for digital character costume design in *Puss in Boots*. Mussenden used the colours in these tiles and mosaics for the colour scheme in the film's costumes. Courtesy of Isis Mussenden.

inner body and consists of their embodied feelings, rather than addressing a body, which is merely a representative figure. Shusterman (1999: 302) discusses 'experience' in relation to this somatic element of perception: what is seen is felt in the body. Through this point of view, the costume designer's exploration of visual materials (in general) via vision also conveys somatic feelings, such as the experience of touch, which guide their costume design development. In her analysis of haptic visuality, Marks (2000: 129) similarly argues that the 'experience of looking … makes us reflect that memory may

be encoded in touch, sound, perhaps smell, more than in vision.' From Marks' phenomenological perspective, there also lies a connection between the somatic and aesthetic experiences, including tactile dimensions. Hence, by perceiving different visual materials through vision, the costume designers experience the "feel" of the textures, for example, their softness or roughness. In the case of *Puss in Boots*, Mussenden (2018b) points out that the 'rhythm of the details' in the visual materials (e.g., in Figures 69 and 70) guided her decisions regarding the colours and textures in the costumes. Such a comment showcases the multisensorial effect of an image. The "rhythm" generates certain feelings that intuitively guide the designer in costume-related decisions, such as material texture or repetition of colour or pattern on a fabric. In this case, selecting the colour scheme through somatic, tactile, and aesthetic means consequently transforms it as a digital entity in the computer-animated film. Thereafter, the spectator is able to enter the world of the film through specific colours that reflect the aesthetic and cultural context in which the story develops – in the case of *Puss in Boots*, the history and culture of the Spanish region.

In addition to these tactile, non-costume-related inspirations, other visual references such as paintings can help generate ideas that inform historical garment construction, materials, and details as part of the digital character costumes.[50] Reproducing specific details from certain historical images enhances the spectator's visual connection with time periods through the costumes. Mussenden drew inspiration for costumes in *Puss in Boots*, for example, from copies of Marco Marziale's painting "The Circumcision" (undated) and Albrecht Dürer's "Portrait of a Young Venetian Lady" (1505) (Figures 71 and 72). Mussenden's description of '*Richness in detail*' (see handwritten note next to the reference painting in Figure 71) refers to the different material texture finishing and cloth volume in upper-class clothing during this specific Renaissance time period. Her note '*trim textile detail*' (handwritten note next to the reference portrait in Figure 72) connects with examples of details in female garment construction at the time that were employed as inspiration for some costumes for female characters in the film. These kinds of details can be interpreted digitally by the animators in the costumes to convey cues of the time period or character's status.

[50] This is also a common way to work when exploring visual inspiration for costumes in live-action filming and live performance: therefore, it is not solely distinctive to costume design in animation.

Figures 71 and 72. These visual images provided ideas of period-specific garments and textures for digital character costume design in *Puss in Boots*. Figure 71 is a copy of "The Circumcision" by Marco Marziale, (undated), housed at the National Gallery, London. Figure 72 is a copy of "Portrait of a Young Venetian Lady" by Albrecht Dürer, 1505, housed at the Kunsthistorisches Museum, Vienna. Copies courtesy of Isis Mussenden.

The use of a large selection of visual material references assisted in achieving a richer visual quality in the costumes in *Puss in Boots*.[51] Figure 73 shows a collage of additional visual references that depict textiles and draped garments, some reminiscent and some authentic of the Renaissance time period. The richness of the material textures in these visual references enabled Mussenden to feel the materials even though she was not physically touching them. As Marks (2000: 2) argues, perceiving through vision, the eyes operate as organs of touch, where vision is connected with our bodily experiences. This is a clear example of haptic visuality, that is, the ways visual images convey tactile dimensions to the viewer, such as embodied feelings of how materials feel on the body. Similar to Marks, Barker (2009: 2) agrees

[51] The inclusion of a wider variety of textiles and textures in the costumes in *Puss in Boots* compared to the films *Shrek* and *Shrek 2* that were produced much earlier is also connected to developments in computer animation software. The wealth of visual materials used in this film supports my argument in the previous chapter that the development of technology affected how costume texture surfaces were digitally animated. Therefore, it offered a place for costume designers to implement a large selection of visual materials in costume design development. As such, rich details could be achieved digitally in the costumes.

that skin, muscles, and vision are immersed and that touch is deeply experienced not only in the body's surface but its depths. Vision is linked with bodily experiences and based on a prior understanding of the tactile feeling of different textures, such as velvet, brocade, or silk. Each image transfers the feeling of these different materials in the designer's soma, which guides the costume development. For this reason, the costume designer implements specifically chosen textures and colours of these visual references in the costume design. In addition, the costume designer's own professional experience informs the decisions of selecting these specific visual references. In this case, Mussenden's knowledge in textiles and garment making guides her choices in designing the different textiles for the digitally animated costumes.

Visual images of textiles also functioned as a direct reference for costume designs in *Puss in Boots*. Imelda, the San Ricardo orphanage leader, is

Figure 73. This example page includes a collage of visual references supporting the interpretation of ideas from the Renaissance paintings (in Figures 71 and 72) and provides a greater variety of textures and weaving design ideas for the character costumes in *Puss in Boots*. Courtesy of Isis Mussenden.

a character with a small but important part in the film as caretaker of Puss when he was a kitten. Mussenden's image examples of different cross-stitch work and embroidery show a connection with the costume design of Imelda. Comparing the two images, Figure 74 illustrates a textile reference, and Figure 75 visualises the reproduction of the reference in the digital costume. The two images demonstrate that the visual reference of the cross-stitch inspires the digital costume. However, the visual reference of the design is not specifically copied in Imelda's blouse. Therefore, it is not a reproduction but a general idea of the cross-stitch design, its colour, and texture transferred in the digitally animated costume. This visual reference also inspired the pleating detail on the front part of the blouse in the film. Thus, a combination of details in the visual image(s) are adapted in the costume design, not necessarily by directly copying them but by implementing a general idea into the overall design. The feel of the texture of the embroidery as well as the blouse material are features that Mussenden conveys from the image through sensory/haptic visuality, via her vision without touching the materials. Haptic visuality draws on senses, in which the viewer's body is involved in seeing (Marks 2002: 3). Vision transfers embodied experiences, where perceiving the image through vision, Mussenden interprets other sensorial aspects of the image, such as the feel of the texture and weight of the fabric in the final costume design. Mussenden (2018b) points out that in *Puss in Boots*, the visual references were also 'samples of pattern, colour, embroidery, things like that,' which assisted the animators to digitally produce the textures on the computer-animated costumes. This means that the tactility in these visual images was not only informative for the designer in the costume design development, but also for those animators who work with simulation and shader programs and build costume textures for the digital characters. The visual image references inspire the tactile experience of the cross-stitching, colours, and pleating – all material qualities that the visual image conveys.

Figure 74. (left) Mussenden's visual reference of cross-stitching, which appears to be part of a folk costume. The richness of texture in this particular image enables better translation of the design in the animated garment. Courtesy of Isis Mussenden.
Figure 75. (above) The stitch design is transferred to orphanage leader Imelda's blouse; however, the texture is flatter. Screenshot (cropped) from *Puss in Boots*.

Other designers conducted similar visual and tangible material exploration as part of their work across the case study films. Regarding tangible materials references, in his interview, Segal showed a box full of different fabric samples he collected while developing costume designs for *Shrek the Third*. In his design process, he explored material qualities through touch, such as texture, thickness, weight, and colour tones of these fabrics. Some samples were used as additional reference material in collaborative discussions regarding the costume designs and others as material references for his costume designs. In such instances, these were attached with the final costume design drawings (see Figures 76, 77, and 78).[52] The need to touch and examine these physical fabrics connects with somaesthetics: the somatic experience that the material examination transfers is part of digital character costume design. Touching the tangible materials offers another perceptive dimension to costume designers in the costume design development and to animators in the digital creation of the costume. Touch enriches the somatic experience of materials from vision, such as the fabric feeling in the "soma," whether it is hard or soft against the skin, whether it has weight and puts pressure on the skin, or produces material sound.

[52] Figure 77 is Israel Segal's final costume drawing with material references for the character Queen in a scene where she mourns at the King's deathbed in *Shrek the Third*. In Section 4.1, I discussed how the Queen's dress style (the costume model) was reused and the appearance of a new costume was created by changing the colours to reflect the particular mise-en-scène. Figure 78 is the costume drawing with material references for the school uniforms on the generic characters in *Shrek the Third*, discussed in Section 4.4.

Figures 76, 77, and 78. Examples of tangible material references included in Israel Segal's costume drawings for characters Fiona, the Queen, and a generic character in *Shrek the Third*. Courtesy of Israel Segal.

Danny Flynn's costume design development shows how visual and tangible materials served as important reference materials in digital characters' costume design in *Big Hero 6*. In contrast to the historical setting in *Puss in Boots*, *Big Hero 6* a science fiction film placed in a futuristic city where "hi-tech" inspired the film's visual aesthetics. As discussed in Chapter 3, *Big Hero 6* takes place in the imaginative city of San Fransokyo where Japanese influence was explored as a design option across the film, visible in the environment (e.g., buildings and architecture), but also in the realisation of the futuristic superhero costumes. In order to support the form, construction, and materials in the character costumes, Flynn explored high-end fashion from magazines and fashion photography as well as Japanese pattern books as visual references. Flynn himself owns a second-hand clothing store in Los Angeles, which specialises in high-end fashion and Japanese avantgarde clothing, including brands such as Issey Miyake, Comme des Garçons, and Yohji Yamamoto. Flynn also included clothing from his own store as garment references, specifically to respond to the film's Japanese influence (Flynn 2017).

The futuristic superhero costumes in *Big Hero 6* required tangible material references for implementation in the designs. In our discussion, Flynn (2017) explained that in addition to the visual materials, the majority of his costume design development included tangible material exploration. He searched for all kinds of materials, not only fabrics related to garment making. Flynn explains that he discovered the most interesting material samples from all kinds of locations, such as hardware stores or flower shops, not only fabric stores. For example, plastic shower curtains provided a variety of shiny textures, and bathroom mats with a rubbery surface underneath presented interesting textures to implement in the designs. One interesting material he recalls using was wrapping paper for tulips found from a flower shop in downtown Los Angeles. Flynn explains that this material was paper attached to tin and had an interesting silver metal texture that he thought would be worth using as a reference in the costume design. The film's art direction, having technological and futuristic visual dimensions, inspired these kinds of material choices for the costumes. Plastic and hard surfaces and geometric shapes were concepts for costumes in *Big Hero 6* costume design development.

Employing such a large selection of different materials and especially conducting costume design development by heavily leaning on exploring tangible material references connects to a somaesthetic experience. Flynn searched for diverse material options where both somatic and visual aspects guided his material selection. Observing the materials through vision and touching them as material objects, ties closely to Shusterman's idea that the somatic experience is unified with an aesthetic notion. Touch is an additional sensory reflection and connects with the multisensorial aspect of perception and embodied feelings of somaesthetics. Flynn makes costume design–related decisions through somatic experience gained not only through vision but also through the tactile dimensions. The superhero costumes in *Big Hero 6* include textures not originating from mundane clothing materials, and these kinds of materials, as any, require real-life references to explore the tactile feel of the material in the designer's hands. The unity of touch and perception and the feelings elicited in the soma are vital because the softness, roughness, thickness, or colour of the material leads to design choices in the digital character's costume design.

The appearance of the character Baymax shows the inspiration of tangible, real-life material references in the character design development. In the film's narrative, the character is a robot, built as part of a scientific project at the San Fransokyo Institute of Technology to provide medical care to humans. Flynn (2017) recalls that when Baymax's visual appearance was first presented to him in the production meetings at Disney, 'the character looked like a Michelin man,' and he felt that the design should be altered to

Figure 79. The design and outer layer of a Comme des Garçons skirt were physical garment references employed in digital character costume design in *Big Hero 6*. Courtesy of Danny Flynn.
Figure 80. Danny Flynn shows the skirt material in more detail and the plastic air pockets placed inside the hemline of the skirt. These create a puffed, round look for the skirt hem. The same effect was implemented in the design of the overall look of character Baymax. Courtesy of Danny Flynn.

Figure 81. Character Baymax's visual appearance in *Big Hero 6*. Screenshot from *Big Hero 6*.

a more contemporary form. As one example of Baymax's surface material, Flynn chose to present a white skirt by Comme des Garçons from his Replika Vintage clothing store. The skirt material was made of man-made, polyester-type fibres and comprised two fused layers. The inner layer was thicker but soft, making the skirt surface feel and look softer. The thicker inner layer gave the skirt a stiff appearance when hanging (Figure 79). In addition, the skirt hem was partly folded and sewn, and plastic air pillows attached inside the folded hemline, which produced a soft, round appearance (Figure 80). The softness of this skirt texture and the round design corresponded to the character's kind, soft personality and chubby/round form (Figure 81).

In the case of Baymax, the costume designer's examination of the dress texture supported a better grasp of the look (aesthetic level) and feeling (somatic and embodied levels) of the physical material in the real world first, which was then implemented in the character design. When examining real garments and their texture qualities, the costume designer experiences somatic, embodied feelings regarding the form and texture of the garment. For example, the Comme des Garçons skirt material proved especially suitable for Baymax due to its texture and form, which suited the character's round body form and gentle, soft personality. When Flynn chose this garment as tangible reference material, he made the decision based on his own somatic and embodied experiences of this specific material. Thus, selection of tangible material references for digital creation and the "truthful" reproduction of the tangible materials emerges from this study as important steps in digital costume creation.

Once the material qualities are digitally reproduced in the computer-animated film, somatic feelings regarding the softness of the material are evoked in the audience through sensory perception. Barker (2009: 46) remarks that equally to live-action film, digital textures also stimulate audience experiences that reside at the surface of their skins. Digital media is not without tactility and has a skin that the viewers touch haptically 'and in such a way as to remind us of the degree to which emotion, memory, and history emerge in and are shaped by tactile engagement between film and viewer.' As Barker (2009) argues, the audience's response varies between each spectator where their personal histories affect their response. The tactility of digital materials transfers bodily experiences that are personal to each viewer. This also connects to Monks' (2010: 24) argument highlighting the embodied feeling costumes transfer, which 'is often mediated by the feelings created by wearing clothes,' which is always subjective.

In addition to the use of tangible materials, visuals also inspired Danny Flynn's costume design in *Big Hero 6* in the outcome of the young, female character Go Go Tomago's costume. Go Go Tomago's personal characteristics are introduced to the spectator as athletic, with a passion for speed

Figures 82 and 83. Two visual images of Pierre Cardin outfits (circa 1970s) were Danny Flynn's inspirational references for the character Go Go Tomago's superhero costume in *Big Hero 6*. Images are copies from Hesse (2010: 60, 100–101) *Pierre Cardin: 60 Years of Innovation.* Courtesy of Danny Flynn.

and racing. From a vast selection of vintage, high end, and futuristic fashion images, two visual reference images inspired the texture and shape of the character's superhero costume. The design evolved from two images taken from the fashion book *Pierre Cardin: 60 Years of Innovation* (Hesse 2010). One image consists of a black and white dress with a circular design at the front (Figure 82), and another is a collection of suits with circular discs attached to

Figures 84 and 85. The images used in visual exploration at an early stage of the costume design development demonstrate that the disc detail was chosen in the final digital design of Go Go Tomago's costume and inspired her action in some of the film's scenes. Screenshots from *Big Hero 6*.

trouser legs by the hem (Figure 83). Flynn specifically used the yellow suit, as well as the discs, as an inspiration for the design of Go Go Tomago's futuristic superhero suit.[53]

The final version of Go Go Tomago's superhero costume in *Big Hero 6* shows a blend of these two images translated into the character's costume design (Figures 84 and 85). Flynn's visual references from a very early stage of the costume design process proved useful for the entire character design. The designer perceived aspects of the form and material of the visual reference and developed them to reflect the character's passion for speed. The discs in her costume are like wheels enabling Go Go Tomago to ride fast, inspiring some of the character's action in the scenes, for example, the scene when she rides with the aid of the discs faster than the others. In addition to the circular forms transferred to the digital costume, the yellow colour from one of the original reference images appears in the character's costume,

[53] Flynn (2017) remarks that these two visual references were already part of his portfolio, which he presented at Disney when he applied for the costume design position.

together with black and red. These colours belong to the original character design of Go Go Tomago in the Marvel comics and links the character to its original design.

To conclude, this section focused on costume designers' inclusion of visual and tangible material references in digital characters' costume design development. Costume designers explore a vast selection of visual and tangible materials in order to bring broader visual quality and more imaginative design solutions into films' costumes. These diverse traits are transferred to the costumes as a variety of texture surfaces, volumes of cloth, or range of colours. The empirical data analysis reveals that visual materials are explored for their tactile dimensions, which transfer somatic experiences through sensory and haptic perception. Perceiving colours, textures, and details in the visual images though vision conveys somatic feelings to the designers guiding the designs. Tangible materials, textures, and garments are explored by touching and feeling them, as touch encompasses a range of embodied experiences that facilitate design ideas for character costumes via somaesthetics. A connection exists between the surface texture of visual and tangible materials, as each object has its distinctive texture. Thus, tangibility emerges an essential reference point for designing digitally animated costumes.

5.2 Two-dimensional patterns turn to three-dimensional digital costumes

An interesting parallel exists between the real and the digital when digitally animated costumes are built. Tangible patterns and pattern cutting skills commonly employed in real garment making are also integral in digital character costume design, where the costume designer's professional expertise plays a vital role. During the production of the case study films, each costume designer reported making physical pattern references. Physical patterns impart details on transforming two-dimensional shapes into three-dimensional garments.

In computer-animated film productions, physical patterns enable the design to mimic a certain garment digitally by providing an understanding of how two-dimensional, flat surfaces transform into three-dimensional costumes. As early as 1992, Carignan et al. presented an approach to develop costumes on a synthetic human character[54] (based on physical human motion) in animated entities, which is, in fact, a similar approach to how tailors work. The digital garments begin from two-dimensional panels that replicate patterns, and these patterns are virtually "sewn" together. Carignan et al. argue that in order to create a dress that functions believably on a female body in the digital world, it should be based on similar methods of garment creation as in real life.

Animated films quite often present characters whose body figure dimensions appear exaggerated from a traditional physical human form. Consequently, the costumes on these different body types require alterations for the patterns that form their digital costume, similar to pattern cutting for real garments. Kalal et al. (2009) state that traditional tailoring techniques are employed in creating digitally animated costumes; however, in the case of exaggerated human body forms in animation 'a challenge arises when using traditional patternmaking techniques to clothe these characters as their proportions vary vastly from those of typical humans.' Kalal et al. discuss the character body shapes in the computer-animated feature *Up* (Docter and Peterson, 2009) as an example. The Pixar film tells the story of an elderly man, Carl, who turns his house into an airship by using thousands of helium balloons to travel to Paradise Falls to fulfil his and his late wife's dream. However, a young boy named Russell accidentally joins Carl's journey while trying to earn his final boy scout merit badge. In the film, Russell's body type is designed as short with an extremely round figure in contrast to Carl's, whose form takes on a square shape (see Figure 86). The round-figured Russell wears a buttoned shirt and shorts indicative of a typical scout's outfit, but his short thick legs and large round waist required alterations to his shirt patterns. The round shapes were achieved by adding darts to the patterns of Russell's shirt and shorts. As in traditional pattern cutting, darts specifically allow the creation of a rounded, three-dimensional form in a garment. However, to achieve the round shape of the animated character, the darts were positioned in several locations that differ from traditional patternmaking (Kalal et al., 2009). The creation of a digital pattern reflects the shape of the body, and the costume's three-dimensional form clearly replicates the making of physical clothing.

[54] A synthetic human character is similar to a digitally animated character.

Figure 86. Costumes on the round body shape of Russell and square body of Carl required specific patterns. Screenshot from *Up*.

The previous industry paper examples (Carignan et al. 1992 and Kalal et al., 2009) correspond with the costume designer interviews, in which each described providing patterns to support the digital costume's animation. From the production of *Shrek* to *Big Hero 6*, digitally created garments still required similar patterns as in real garment making, regardless of advancements in software. For example, *Shrek the Third* was produced five years after the first *Shrek*, and the animation computer technology had improved in executing realistic depictions of material behaviours (such as wrinkles) and material surface textures. However, physical patterns were used for more complex garment shapes.[55] Costume designer Israel Segal (2017a) recalls making patterns, for example, for the early 17th century men's breeches, used in one of Shrek's costume designs.[56] The subsequent production of *Big Hero 6* indeed benefitted from even more advanced computer animation given that it was produced nearly ten years after *Shrek the Third*; however, digital character costume design still required real-world patterns. Flynn (2017) offered Japanese pattern books to the production team at Disney so that they could study how the extravagant shapes of Japanese garments are constructed and how to transform these shapes into digital costumes.

During the production of *Shrek*, patterns were also necessary for the character animators and cloth simulators to better understand the creation of different costumes and the fit of a garment on a human body. Mussenden (2016a) recalls demonstrating different skirt types with physical patterns, as those clearly indicated how the garment shape depends on the shape of the pattern. Mussenden (2016a) expresses that 'my understanding of fabric, pattern, and cut helped them to understand what makes up a skirt and why dirndl is a dirndl, A-line dress is A-line dress, or something that's gathered or a thing that is not.' *Shrek*'s art director Aretos (2017) also explained that in creating digital garments, understanding of patterns and garment construction is critical, as 'of course the way a dress is sewn and cut has a huge impact on the way it reacts and moves.' These comments are consistent with those of Carignan et al. (1992), and Kalal et al. (2009), confirming that the laws of physical pattern cutting are replicated in the creation of digital garments.

One concrete example of a physical pattern created by Mussenden for the production of *Shrek 2* illuminates how and why physical patterns are used in computer animation. In the film's narrative, Shrek transforms from an ogre into a human form after drinking a magic potion offered by the Fairy Godmother. Even though Mussenden was not part of designing the costume for the original ogre character, she designed the costume for Shrek in his human form. The digital version of Shrek's human body figure and its measurements were references for Mussenden in making physical patterns for his costume, which stands out as a distinct example of the process of digital character costume design. The front pattern piece of Shrek's tunic (Figure 87) provides information not only on the shape of the garment but also how seams join. This reference can be used in the cloth simulation stage of the animation, a place when the costume patterns are digitally "sewn" (joined together). Mussenden (2016a) remarks that seam allowances are not needed on the patterns for the digital "sewing" in digital garment creation.[57] Therefore, the width of seam allowances dictated by the location of the seam and thick-

[55] Moszkowicz (2002) makes a similar point in her analysis of *Toy Story* and *Toy Story 2* where the development of technology enhanced the visual appearance of the textures on the toy characters.

[56] The unusual structure and fullness of these breeches was the reason why patterns were needed for the digital animation. As I argued in the previous chapter, men's trousers are often tight-fitting in animated films as they are then much easier to animate with the movement of the character.

[57] This corresponds with similar functions in cloth simulation programs, such as Marvellous Designer or Clo3D, for sewing digital patterns. These programs were originally developed for the fashion industry, but specifically Marvellous Designer is now employed in character development in animation and game industries (see Salomaa 2018). However, none of my case study films indicated that they used this program.

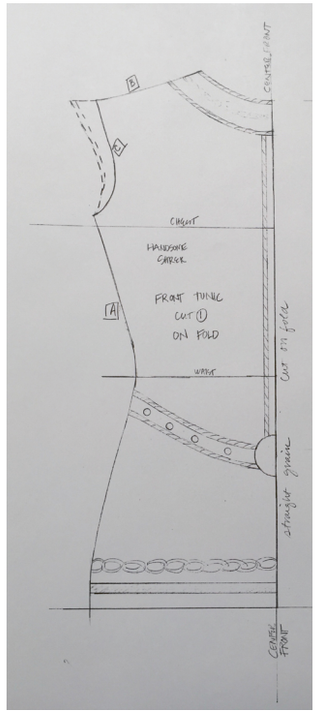
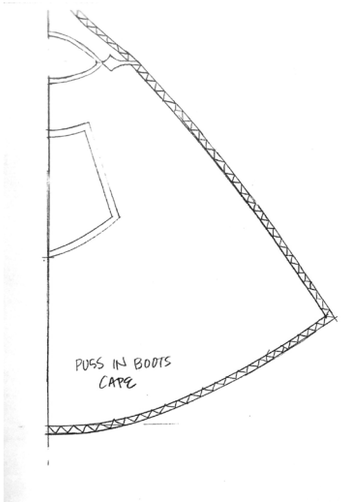


Figure 87. The front pattern piece for the character Handsome Shrek's tunic in *Shrek 2*. The pattern demonstrates that several details regarding the style and construction of the garment can be included in the physical pattern to assist the computer animation. Letter A by the side seam shows the place where the side seams are joined; letter B on the shoulder indicates the shoulder seams; letter C shows the place for the wing. Courtesy of Isis Mussenden.

ness of the fabric does not apply in these forms of digital sewing. This aspect emphasises the difference between making real and digital garments and also suggests that less labour is involved in the digital sewing process as opposed to sewing real garments. The physical pattern of Shrek's tunic additionally indicates the places for specific details in the costume, such as the position for the belt and buckle. Decorative ribbons on the centre front, neck, and hemline are also noted in the pattern to assist in the digital reproduction of the garment.

One piece of information included in physical patterns for constructing the digital costume is that of the grainline, which specifies the way that the material is cut. In her interview, animator Kelly Kimball (2017) specifically discussed the importance of indicating the way the material has been woven and cut in the digital costume creation. Kimball explained that she has demonstrated in an animation production meeting the ways a grainline affects how a fabric folds or drapes on a body. A fabric with a tight weave does not fold or pleat well on a straight grain. However, if the fabric is put on a bias, the folds are softer and the entire material hangs better. Consequently, a garment in which fabric has been cut on straight grain differs from that cut on a bias grain. Such details in the physical patterns inform the digital garment creation in terms of fit on the character and especially how the material drapes. Harris (2013) notes that digital material representations rely heavily on their tangible, real-life versions; consequently, the digital material functions in a similar fashion to the physical material. In digital animation, therefore, knowledge of physical material qualities such as the drape and grainline are essential to animate material movement accurately. In addition, light and shadow reflect differently on materials that are cut either on a straight or bias grain, depending on the material surface. Specific information about physical material quality, such as the grainline, must be included in the digital costume creation.

Another pattern example created by Mussenden shows specifically how the pattern functions as additional support for digital garment construction. The pattern for Puss in Boots' cape (Figure 88) in the sequel *Shrek 2* demonstrates the volume that Mussenden aimed for in the garment's design. When this pattern is passed on, together with the character's costume drawing (Figure 89), the animators working on digital creation of this garment piece are able to achieve a better end result. In addition to the garment's volume, the pattern indicates the place and proportion of the decorative ribbon



Figures 88 and 89. The cape pattern supports the costume drawing, and these both assisted the digital execution of the attire on Puss in Boots in *Shrek 2*. Courtesy of Isis Mussenden.

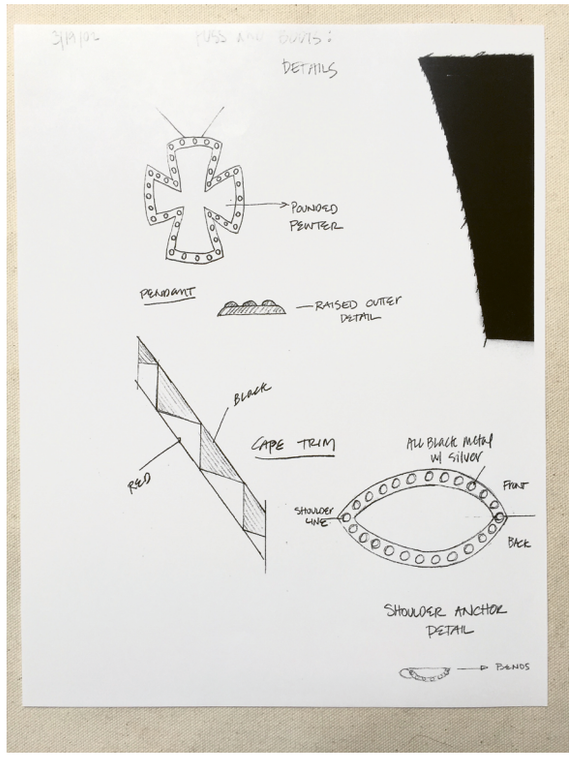


Figure 90. Isis Mussenden made accurate drawings to indicate more specific information regarding the details on Puss in Boots' cape in *Shrek 2*. Courtesy of Isis Mussenden.

framing of the edge of the cape, the shoulder point, as well as the place and size for the coat of arms figure at the back. The pattern has been drawn to a quarter-scale to allow calculation of exact measurements for each seam and the size of the garment. Similar to the previously shown pattern of the tunic for Handsome Shrek (human form), both these patterns function to clearly demonstrate the cut, volume, and details in the garment and offer supplementary details of shape, volume, and placement.

Costume designers in the case study films also gave the animators detailed drawings with further information to support the details indicated in the physical patterns. For example, in addition to the pattern and costume drawing, Mussenden made more accurate drawings that indicate the depth, materials, and colour of the decorations in Puss in Boots' cape (Figure 90). The drawings illustrate in detail the design and colour of the decorative ribbon framing the cape, the pendant hanging at the front, and the style of the anchor on the shoulder. The drawings also specify the depth of these details, which is required for three-dimensional creation. As I discussed in Chapter 3, several professionals execute the digitally animated costume in computer-animated films. However, digital animation is mostly performed without the costume designer working alongside the technical professionals such as animators and cloth simulators. Therefore, the process of building costumes digitally requires detailed information regarding all aspects of the costume design, including its dimensions.

Puss in Boots' cape includes another example of transferring information from physical patterns to a digital costume. Although detailed costume drawings and patterns are passed on to the animators to create the costume digitally, the design may change during the digital animation. The comparative analysis shows that in the case of the cape, the details included in Figures 88 and 90 are not all transferred to the digital costume. A comparative analysis reveals that in the animation, the two-tone black and red trim that frames the cape is executed digitally as a single dark red colour. Additionally, the decorative pendant that hangs at the centre of the front of the cape in the costume drawings is replaced by a round buckle on top of the front part of the cape (see Figure 91). The shoulder anchors of the cape are hardly visible when the character moves, and the fullness of the cape has also been minimised (Figure 92). In my opinion, these changes most likely allowed for an easier animation process when the character moves, particularly as cats are more agile than humans. For example, the hanging pendant moves independently from the character's body and creates a secondary motion, which requires treating the pendant individually in movement – which is more time consuming to animate. The same also applies to the wide cape design. As discussed in the previous chapter, larger volumes of cloth are more problematic to animate than tight-fitting garments due to secondary motion and collision. Consequently, Puss wears this cape only briefly in his introductory scene, and it is evident as he begins jumping around and also upside down, that the movement of the cape was difficult to manage in the animation process. Although a valuable accessory, the cape becomes secondary in the character design due to time-consuming animation. A cat's movements with clothing already make the animation process challenging.

The tangible materials, in this case, the physical patterns, are essential for the animators to create the digital costume successfully. Consequently, tangible patterns are digitised for computer animation and thereafter virtually sewn, replicating the real-life garment making process. Material weight, thickness, and texture properties are also included in the garment to gen-

Figures 91 and 92. The final animation shows that the design for Puss' cape and its details differ from Isis Mussenden's original designs. The pendant, ribbon, and volume differ from Mussenden's original costume drawing. Figure 91 screenshot (cropped), Figure 92 screenshot from *Shrek 2*.

erate the appearance and effect of real-world materials, such as weight, thickness, and texture. These features also influence the garment material behaviour. An interesting relationship exists between the real and the digital. The physical laws of the real world are translated into the digital costume, where tangible information such as the patterns play a key role.

To conclude, in these case study films, the physical patterns in digital character costume design serve as a tool for a better understanding of the

garment structure, its construction, and additional details included in the designs. In digital garment creation, pattern construction and shape affect a garment's form, its fit on the body, and its response to the character's performance in action. In the studied films, physical pattern references were still required despite advanced technology enabling a more manageable and faster digital cloth simulation. Physical patterns also prove useful in constructing costumes for characters with exaggerated body proportions. Understanding how two-dimensional patterns create a three-dimensional form, in real life and digitally, requires expert professional knowledge in garment making, as acknowledged by the industry in Kalal et al. (2009) regarding patterns and tailoring costumes in Pixar's computer animation *Up*. The physical dimensions of real garments are reproduced in digital costumes, first as patterns, and thereafter as material weight, thickness, and texture properties included in the digital costume, replicating their real-world examples. This empirical data analysis supports the inclusion of a costume designer in the production to provide detailed guidance for digital garment creation. These detailed physical qualities of garment making add credibility and authenticity to digital costumes.

5.3 Costume in motion

Costume design development for digital characters includes real garment examination, demonstrating another tangible material dimension of the production of computer-animated films. These tangible garments are physical versions of the animated costumes and are used on human subjects to enable the animators and designers to examine the costumes in real life and in movement before animation. The real garment examination relates to motion studies and rotoscoping,[58] which have been part of the character design process since the early hand-drawn animated films that presented human characters, such as Fleischer Studios *Snow White* (Fleischer 1933) and Disney's *Snow White and the Seven Dwarfs*. The rotoscoping technique traces the human movement from live-action film frames to animation cels, whereas motion study involves an examination of a live person, which teaches animators to understand human movement and enhances their skills at adapting these movements to animation. This process further assists the an-

[58] Rotoscoping technique was patented by Fleischer Studios in 1915. For more on Rotoscoping, see Cartwright (2012).

imators in drawing the characters' performance more realistically (discussed earlier in Chapter 3). For Disney, motion studies were important because the studio specifically introduced the "hyper-realist" (see Wells 1998) style to animation in Hollywood.

A similar examination of human physicality and motion has also proved useful in computer animation, and not just within the development of motion-capture technology, which often accounts for how human movement in animated characters has been understood. In considering costume design, motion study actors wear a real-life version of an animated character's costume as a reference point. Motion study (as perhaps a precursor to motion-capture technology) enables the animators to depict the garments authentically on the character's body and to replicate the fabric texture and behaviour in movement. Different materials react differently in movement and against the body, so physical references offer clues to authenticity of such features. Furthermore, different textures are tied to a specific material's weight and how materials drape on the body. Motion study examination also enables the identification of where light and shadow fall on fabric (see Kalmakurki 2018; Kalmakurki 2021), which is important for reproducing costumes in a credible way. As Boumaroun (2018) attests, reference photos taken from multiple angles of a real person wearing a costume are informative for marking character silhouettes and garment fit. Studying human motion in costume assists in creating the important continuity in characters' silhouettes, but also depicting fabric qualities and textures.

Understanding different garment structures for realistic animation necessitates real garment examination. A specific example stems from Kelly Kimball's (2017) interview, in which she discussed animators' preference of drawing the character's arm with a seam by the armhole. The line in this spot separates the arm from the body/torso, and so arm movement is easier to handle in animation. If a costume has a dropped shoulder line, such as the tunics in DreamWorks' hand-drawn animated film *The Prince of Egypt*, physical reference is required to demonstrate how this specific garment construction functions as part of the character's performance. The tunic's shape and construction differ from a typical set-in sleeve that is not tight on a body, which also requires further examination of its behaviour in real life in human movement. In this case, motion study assisted in the understanding of this unusual garment structure and consequently eased the animation process of the secondary motion of the loose sleeve. As part of animating character costumes in *The Prince of Egypt*, Kimball constructed a linen tunic for a woman to wear and presented the form of the garment to the animators. Kimball (2017) recalls that 'they actually did a video of this woman moving around lifting her arms because it's not a set-in sleeve… just so they see how that garment, that's not fitted to the body behaves.' Perceiving the physical garment on a human body and how it would move in relation to the character motion was crucial for understanding the specific garment structure, especially in movement. These features could be thereafter interpreted in the animation to enhance the authenticity of the character's performance.

In computer-animated film productions, a similar type of motion study process, used in character animation in hand-drawn animated films, aids digital character costume creation. Where the character's motion replicates the physicality and laws of the real world, the examination of physical examples enhances the digital animation. Mussenden (2016a) discusses the same issue as Kimball regarding the seam line on the character's armhole, however, in relation to the digital character's costume design, rather than Kimball's example of hand-drawn animated characters. In digital character creation, the seam by the armhole also separates the arm from the body, making the arm movement easier to animate. Mussenden specifically mentions this issue as part of the costume design development for the character Lord Farquaad in *Shrek*. In the previous chapter, I noted the problem of Lord Farquaad's cape covering the arm-body intersection. This correlates to the same arm movement that Kimball discussed in her interview, suggesting that the motion of the character is animated similarly in both hand-drawn and computer animations. In hand-drawn animation, the dropped shoulder line on the tunic could be achieved; however, in computer animation, this feature was withdrawn from the character's costume design. It proved simply too complicated and onerous to achieve with computer-animation software.

Motion studies act as supplementary information to the physical garment patterns in the digital costuming. Mussenden (2016a) states in her interview that at the beginning of the *Shrek* production, she constructed physical examples of different types of skirts for Princess Fiona's dress. These skirts were worn by various production team members, such as the animators who developed the character's digital costume. The physical garments demonstrated to the animators the range of different styles of skirts in a three-dimensional form. These physical skirts worn by the production mem-

bers added to the physical skirt patterns, to further demonstrate that garment shape depends on the shape of the pattern. Motion study enables team members to observe the feel of the material against the body and the behaviour of the cloth. This kind of material examination helps animators embody the personality and physicality of the character through their costume, tying into Crafton's notion of 'embodied animation' (2013: 38), where he refers to the importance of studying the character's role and 'incarnating the character by living it oneself.' As Crafton makes clear, there exists an important relationship between the role of the animator (as an actor) in helping construct an animated performance, but costume also plays a key part in these processes of embodiment. In his personal transdisciplinary study combining costume, photography, and performance, Shusterman (2012) experienced that the gold leotard he wore held a vital role in experiencing another personality different from his own. Shusterman argues that wearing the costume enabled him to forge 'new looks, new feelings, and new identities' as well as 'empowered [him] to enjoy the aesthetic experience of imaginative role playing through costumes' (Shusterman 2012: 258). Shusterman argues that wearing a specific garment evokes embodied feelings and gestures unique to the experience of wearing garments. In the case of examining the embodied feelings that physical versions of the animated costumes convey, their fit on the body and the feeling against the body enhance the truthful reproduction of these elements into the digital costume and consequently, authenticity of the character's performance.

In reference to the movement of fabrics and their behaviour under specific conditions, Mussenden (2016a) explains that in addition to the animators wearing the physical dresses themselves, 'they needed to get their heads wrapped around what a fabric did.' This comment corresponds with Aimee Kutt's (2018) remarks from the digital costume development during the production of *Incredibles 2*, in which real-life clothing worked as physical references for digital costume creation. Kutt explains that the physical garment examples specifically enabled the designers and animators to analyse the construction and fit on the body as well as the material's feel, fabric weight, and movement. Additionally, the motion study pointed out the natural places for tension and wrinkles in the garments and the moments these occur when the person moves. In computer animation, the real garment examination seems to be as important as examining tangible material references, discussed in the first section of this chapter. Harris (2005: 23) also argues that digitally animated cloth replicates the physicality of real materials and the physical 'relationship between the movement of cloth and the body.' On this point, Prince (1996) argues that digitally animated worlds are perceptually realistic because they copy real-world examples. Hence, the audience perceives the digital world through their own understanding of materials and material behaviours where the cut of a garment, specific movement of cloth, and gravity create the kind of garment behaviour that is familiar to the audience. In computer animation, all behaviours of cloth in the digitally animated costume respond to the behaviours of tangible, real-life garments.

The previous analysis shows that even though the costumes in the case study films are created digitally, real garment examination in production is needed to visually perceive the garment on a human body and movement. However, motion study on costumes is often overlooked and forgotten in discussions of computer-animated filmmaking. Motion study is an embodied experience, as wearing a physical costume during the animated costume design development enables the animators and designers to understand on a somatic level how the materials and weight or pressure of the garment feels inside the body, which is essential not only for garment observation but also for envisioning alteration ideas for the costume. In addition, the costume is more easily understood once there is a body underneath, forming and shaping the garment. In relation to physical garments on an actor's body, Gaines (1990: 2) remarks that 'the body gives existence to the dress.' This quote also applies in digital character costume design, as the embodied experience of a physical person 'filling' the real garment provides knowledge on the behaviour of the costume's form as it shows the form of the digitally animated character. Eventually, the shaping of the costume helps visualise the form of the digital character, hence, the critical requirement to reproduce the physical aspects of the costume accurately in the animation.

In conclusion, the data analysis in this section supports motion study as crucial for developing and creating digitally animated costumes. It is an industrial process that enables the observation of a physical garment on a human body enhancing the awareness of the garment's fit, texture, and behaviour in movement in real life for both the wearer and the viewer. Motion study links with the complex collaborative process of making computer-animated films because the garment examination is completed during the phases of character development and costume design. Viewing animated

costume replicas as physical garments on a person in movement enables the animators to digitally replicate the form of the garment while creating the form of the digitally animated character. When animators examine the physical qualities of costume, such as the weight and drape of fabric and its response to human movement, they can replicate elements of its movement and behaviour authentically on the character and character's performance. Digital costumes are a central performance element by illustrating the character's body and emphasising its performance. In costume design development and the digital creation of the costume, motion study functions in two ways. First, it enables an understanding of the garment fit and movement through perception, and second, it helps the designers and animators recognise the feeling of the fit and texture of the garment through embodied experience.

5.4 End result: Digital textures

In computer-animated film productions, tangible materials are also explored during the process when physical material characteristics are reproduced as digital textures. Solomon (2013: 73) remarks in the case of Disney's *Frozen* that real material properties were used as a reference for the digital animation of several costume textures. Tangible materials were replicated for the digital reproduction because material textures helped define differences between materials, for example, lightweight, shiny processed silk differs in texture qualities to rough natural silk. The reproduction of these materials enhances spectators' perception and ability to recognise the diverse material textures. Visual development artist Jean Gillmore argues that in *Frozen*, the tangible material examination was required to replicate those materials in specific cloth simulation and shader programs, to create realistic textures and fabric movement. Material properties and details such as buttons, trim, and stitching were examined visually and texturally. The aim was to depict the finest details in fabrics and their embroidery, as well as to visualise individual stitches (Solomon 2013: 72, 73). Scrutiny of material textures aids in achieving authentic digital texture surfaces and creating, in Prince's (1996) terms, perceptual realism in the digital reproduction of various material surface textures in computer-animated films.

All of the case study films examined for this thesis demonstrated that in addition to exploring tangible materials in costume design development (as demonstrated in the first section of this chapter), tangible materials and specifically their texture qualities were used as references in creating the digital costume textures. To identify the material characteristics in this section, I refer to Ingold's (2017: 102) concept that all surfaces have their own distinctive texture, which depends on the object composition. In the recognition of the texture, we know the composition of the perceived object. For the specific textural qualities to be translated into a digital form, tangible references must be studied. This corresponds with Harris' (2013: 244-245) remarks concerning digital materials, in which she states that the digital material characteristics and properties are informed initially by their surface texture and that the creation of digital material textures relies on their physical versions in the real world.

Different tangible materials were passed on as references for digital reproduction in costume design for each case study film. For example, during the production of *Monster House*, Ruth Myers (2017) describes that she provided 'literally a file box for each character with everything in it' for the purpose of the digital costume creation. The principal characters range from school children to teenagers to an elderly man. This file box included diverse physical materials related to their clothing, such as patterns, garments, buttons, zips, trimmings, even references for the characters' underwear, socks, and shoes. Myers physically painted, dyed, and distressed all of the textiles and garments to match the surface texture that she wished the garment to depict in the film. Distressing the garments added to a more accurate reproduction of the worn look in the film's digital textures to create the "aged" feel for the costumes (discussed in Chapter 4).

Similarly, in all the computer-animated films in which she worked, in addition to physical patterns, real garment examples, and costume drawings, Isis Mussenden (2016a, 2016b, 2018a) provided real material samples of the fabrics she wanted the animated costumes to digitally represent. Mussenden (2016a) recalls that 'the more information I gave, the less they had to go and look for that.' This comment refers to the amount of time the animators require to create digital textures. Creating digital textures with animation software is more straightforward when material samples are ready at hand to be explored and implemented in digital creation. Mussenden (2018a) wanted to pass on different fabrics to be physically examined, for example, to feel the softness, roughness or sheerness of the materials. Such observation of materials through tactile and aesthetic dimensions is a so-

maesthetic practice, where Shusterman (2012:3) argues that 'aesthetic experience in the special sense of art can thus be better understood through a better grasp of its underlying ground in more basic forms of perceptual experience that are also essentially and actively embodied.' As touch is related to what we perceive, exploring tangible materials by touch expands the somatic and aesthetic experience of the materials and enhances a more accurate level of reproduction into digital form.

The material textures of tangible references were directly digitally reproduced on character Jenny's costume design in the production of *Monster House*. Jenny is a 12-year-old schoolgirl and a friend of the two main characters D.J and Chowder. Figure 92 illustrates the physical garment references for the character's school blazer and shoes. In addition to referencing the material texture, the blazer demonstrates the garment's construction, indicates details such as the pocket, and the school shield emblem on the chest. Analysing Figure 93 reveals that these details in the jacket are translated accurately in the digital form, confirming that the physical reference functioned as a clear reference for its digital reproduction. In addition to the physical blazer sample, the shoes were also direct material reference, as their design, colour, and texture surface appear accurately reproduced in the digital form. Each surface materials' distinctive textural qualities from the physical material texture are conveyed in digital reproduction. Therefore, arguably, the same material characteristics can be perceived in the digital costume. Prince (1996: 31–32) argues that artists create digital images by constructing 'photographic realities' as digital forms, which become a 'perceptually realistic image.' The accurate depiction of the physical material characteristics in the digital costume helps the spectator understand the costume and its materials. When the same material characteristics have been accurately reproduced digitally, the level of accuracy enables the spectator to "feel" the material's behaviour and its function through sensory perception. Marks (2000: 127) calls for 'the memory of touch' in relation to the power of vision in connecting other perceptual senses such as touch. She notes that 'certain experiences are most likely to be "recorded" only in the non-audiovisual registers of touch, smell, and taste... Senses that are closer to the body, like the sense of touch, are capable of storing powerful memories that are lost to the visual' (200:130). The multisensory quality of perception evokes the memories of tactile materials via the sensory perception of the digital costume materials.

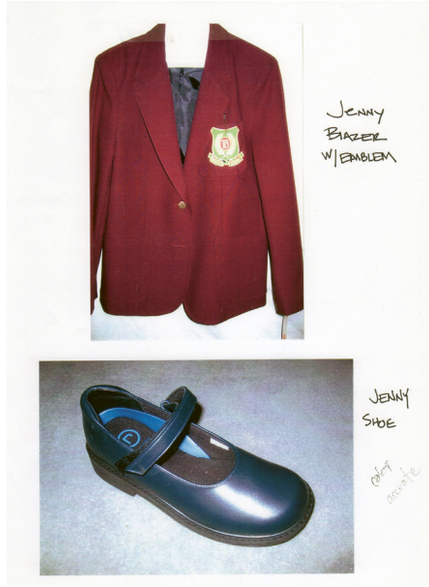


Figure 93. Photos of costume designer Ruth Myers' jacket and shoe references for the schoolgirl Jenny in *Monster House*. Courtesy of Ruth Myers.

Figure 94. This screenshot demonstrates that the physical references of the jacket and shoes are reproduced accurately in the digital costume. The colour and shine of the shoes resemble the original tangible example of shiny leather. Screenshot from *Monster House*.

In the digital effect of Jenny's shoe materials, a closer examination shows how light and shadows achieved in the digital texture impact the success of the truthful reproduction of the tangible reference, the shoe Myers provided for digital animation. Without such effect, the surface texture would resemble a matte surface, having less connection with its physical reference. In the frame of tangible, real-life materials, Ingold (2017: 102) remarks that tangible material surface textures are 'revealed in subtle varia-

tions of pigment and illumination, and especially of light and shade.' Visual analysis clearly indicates that the physical materials translate comparably in the digital form where in addition to accurate colouring, the shine on the (physical) shoe material defines the specific material texture as shiny leather with a hard surface. In this example, digital reproduction follows the same parameters of the real world. Harris (2013: 245) points out that digital surface textures are defined specifically by a variation of light and shade, and their material characteristics determined by the composition of shaders applied to the digital form. Fife Donaldson (2018: 82) adds that 'as with textures in other forms of visual art... CGI incorporates the way light is used to register the qualities of different surfaces.' Based on this, creating the digital surface textures follows, in Prince's (1996) terms, "perceptual realism" via the same principles of the light and shadow in real-world surface textures. Recreating the accurate texture qualities of costume materials, as seen in the costume

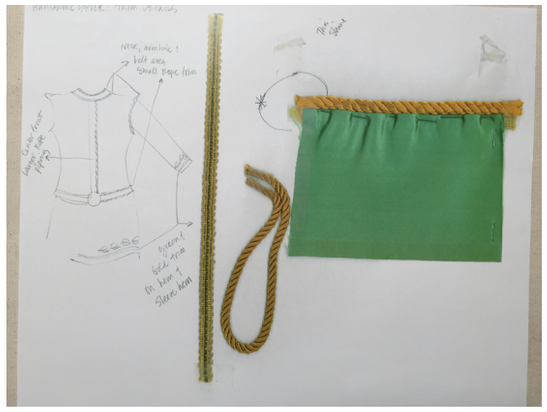


Figure 95. Isis Mussenden's costume drawing depicts the costume ensemble for Handsome Shrek after he has transformed into a human form. The size and repetition of the print on the vest over the tunic are successfully reproduced in the digital version. Courtesy of Isis Mussenden.
Figure 96. A more detailed drawing of the tunic and tangible material samples of the trimmings assisted in the computer animation of the costume. Courtesy of Isis Mussenden.

Figure 97. Drawing of the print design illustrates the repetition, colours, and materials for the vest. Courtesy of Isis Mussenden.

examples in *Monster House*, relies on the accuracy of the light and shadow that consequently affect the perceptual realism of the digital surface, as those increase the level of authenticity of the material.

Shrek 2 offers an example of how the tangible references' texture qualities were transferred as digital surface textures. Tangible materials, especially the colour, print design, and costume details were successfully reproduced in the Handsome Shrek's costume (human form). Earlier in this chapter, I presented the pattern that Mussenden made for the tunic for Handsome Shrek's human body figure. In addition to these patterns, Mussenden also provided various physical material textures as a reference so that the digital reproduction would achieve a rich visual appearance by reproducing many different textured surfaces on the digital costumes (Mussenden 2016b). Her costume drawings depicted the costume design (Figure 95), indicating not only the design of the costume ensemble but information on the size and repetition of the print on the vest over Handsome Shrek's tunic. Mussenden also included detailed drawings of the tunic structure and passed this onto DreamWorks animators as reference together with tangible materials such as sateen fabric and trimmings (Figure 96). In addition to these references, Mussenden drew a more accurate version of the print on the vest over the tunic, indicating its colours and materials (Figure 97).

Due to the accurate costume drawings and the print design produced by Mussenden, the entire print on the vest was successfully reproduced in

Handsome Shrek's digitally animated costume (Figure 98). Furthermore, the real material references of the trimmings assisted the accurate digital reproduction of those particular materials. Through the material references, the animators who work with shader programs that digitally reproduce specific real-world material qualities (e.g., leather, denim, silk) for costumes can physically explore them and implement their quality in the digital form. This exploration can also be referred to as somaesthetic practice, where the senses, touch, and feeling on skin and embodied experiences all facilitate a more thorough understanding of the different characteristics of these tangible materials. Shusterman (2012: 8) argues that it is essential to explore somatic consciousness to improve our somaesthetic knowledge and perception. Therefore, somaesthetics is valuable for drawing attention to the important bodily awareness of the tangible material exploration and the creation of digital materials. Hence, tangible materials are not only examined for their visual qualities but because of the embodied feelings that these textures transfer inside the body. The multisensorial exploration affords a deeper understanding of the material's tactile feel against the skin and the feeling of this in the digital form, which is not possible from merely viewing an image of the material. Consequently, in Handsome Shrek's digital costume, the decorations on the waist, neck, and armhole possess a three-dimensional and realistic appearance, reminiscent of their physical examples. Such features enrich the visual appearance of the character. Furthermore, these rich details added visual contrast to Handsome Shrek as opposed to the ogre form, in which his costume corresponds to his grumpy characteristics and life in a swamp.

Missing from the Handsome Shrek's human form costume is the sateen material texture from Mussenden's material references for the character. The shiny finish distinctive to that particular material is absent on the costume. The tunic and the vest both depict thick textured finishing with a slight sheen, and therefore the vest appears velvety. Ingold's (2017) and Harris' (2013) observations that the light and shadow define the material texture are also reflected in this example. The matt surface that lacks light creates a different textile surface than one with light reflecting on the texture. The decision to change the texture in the vest to a matte velvet surface in Shrek's costume, on the other hand, creates a contrast to the character Prince Charming's costume, which does depict shiny sateen. The rationale for this decision may have been to allow a contrast between the material

Figure 98. Handsome Shrek's costume ensemble in the final animation shows how accurately Mussenden's costume design has been digitally recreated. Tangible references from the trimmings assisted the digital creation of depth in the pattern of the vest, which brings more three-dimensionality to the costume. However, the texture of the vest appears as a velvet material, which suggests that the sateen material was not included in the digital costume. Screenshot (cropped) from *Shrek 2*.

textures for these two characters: Shrek as a grumpy ogre as opposed to flamboyant Prince Charming. Even though Shrek's outer figure transforms from green, dirty ogre to white, handsome masculine male, his personality remains the same in both forms. The velvety texture and 'stain free' appearance on Handsome Shrek is a contrast to his true identity. This shows that costume is powerful in representing different personalities or creating contrasts between the personality and the outer visual representation.

Such accurate re-production of tangible material textures creates visual aesthetics that appear as realistic and indeed affects the multisensory quality in the perceptual realism in computer-animated films. As Prince (1996: 32–33) argues, the digital worlds are perceptually realistic because 'film-makers build them to do so' as 'convincing photographic realities,' which the analyses in this chapter have clearly shown. On the other hand, what is evident in the case study films is a lack of fulfilling the creative potential of computer animation. Wells (1998: 10) remarks that the animation medium enables characters and objects to defy the laws of gravity and to break the

rules of the real world. This is obvious in computer animations where the digital worlds are built with software that facilitates the creation of imaginative and unrealistic textures. Harris (2005: 25–26) agrees that the digital medium offers possibilities to construct objects which defy gravity and would, hence, not survive in a physical environment. Specifically, the creation of digital textiles 'can be pushed to the broadest limits of abstraction, immateriality, and origination that 3D CG will allow' (Harris 2005: 26). However, features of immateriality in the digital reconstruction of the costume materials and the costume structures in the case study films are lacking; all costumes are created as digitally realistic.

The costumes of these specific computer-animated films do not challenge perceptual realism because the films' focus is on realism and truthfulness, which sometimes constrains the creative possibilities. Creating digitally realistic textures, however, does bring a certain freedom to the designers. Mussenden (2016a) expressed that in animation she could combine different kinds of material textures, colour tones, and patterns. She states that 'here I just go, I would like to have this fabric in this colour and this embroidery or print on that.' This is in contrast to live-action filmmaking, where costume materials mostly rely on what is available, to which Mussenden (2016a) remarks, 'how many times I have been to a fabric store and thinking "oh, this is the right fabric, only if it was green!" That's frustrating!' In the end result, the digital costumes convey broader aspects of costumes: their tactile and somatic feelings that are multisensorial and experienced by the animators and the spectators.

5.5 Conclusion

Even though the final result of materials is created digitally in computer animated films, tangible materials play an important role. From fabrics used for garment making to other materials, such as physical patterns, and real garments, a diverse range of tangible material references were a central part of digital character costume design in the examples that I studied. The research demonstrates that each costume designer explored tangible material examples in their costume design development as part of their work. The representation of digital materials relies heavily on their real-life versions, meaning that the digital material functions in a similar fashion to the physical material. Therefore, tangible materials are essential references, also in the case of defining the digital costume material.

I suggested that tangible material references play a key part in providing somatic and aesthetic references regarding material textures and their behaviour during the design development phase, when designers search for correct materials, trimmings, and details for character costumes. Visual materials that illustrate fabrics and textures are powerful in transferring multisensorial experiences. Such exploration is linked with sensory and haptic perception, where vision is unified with bodily experiences such as touch and feel, and what we see is felt in the body.

Costume designers' and animators' tangible material exploration is connected with somaesthetic practice by considering their personal somatic feelings when they touch and feel the tangible materials. The body plays a crucial role in aesthetic experience, not only in external representation but also in the lived experience. Exploring materials through touch transfers information to the costume designers and animators on the feeling of the texture (e.g., rough, smooth, soft). The feelings that materials transmit in the body lead to design ideas later interpreted in the digital character costume designs and digital material reproduction. The exploration of the tangible materials through touch connects with somaesthetics, as touch broadens perception from vision to multisensorial effects felt in the body, the soma.

The relationship between tangible and digital is evident in the way digital garments are constructed the same way as in real life. Therefore, the costume's form is first explored and refined by examining physical patterns, which demonstrate how two-dimensional shapes create the three-dimensional garment. The three-dimensional garment is also examined through a series of motion study tests, which assist in the embodied understanding of the physical garment on a body and in movement. My study expanded the motion studies further by exploring them as somaesthetical and embodied practise and part of costume design. Observing costumes and their specific visual features such as seamlines, fold, drape, and material weight are all costume design–related areas that the motion study enhances prior to finalising the costume design digitally and animating the character performance. Thus, physical material examination is essential for reproducing physical qualities in digital form.

Additionally, the data analysis showed that tangible references such as garments and material textures help the animators and technical professionals such as cloth simulators who digitally create the different features of digital costumes: their form, weight, material behaviour, and texture. The tactile experience of the tangible material examination also provides somatic and aesthetic experiences that enhance digital reproduction. The multisensorial exploration of material surface textures facilitates a deeper understanding of the tactile feel against the skin and transfers these qualities to the digital form. An authentic and believable reproduction of digital texture and its behaviour afford the spectator the embodied feelings of specific garments.

Clearly evident from the data analysis was the consistent mention of tactile dimensions and experiences by each costume designer. No one shared information on other sensorial effects, such as scent or sound, which are also related to multisensorial effects that materials convey. It can be assumed though, that sound of fabric connects with the multisensory effect of material exploration. Unknown, however, is how materials' sound was considered in the digital reproduction of material qualities in the case study films. In sum, tangible references and physical laws of the real world are reproduced digitally and the highly technological end result, the digitally animated costume, is a combination of physical garment structures, material behaviour, textures, colours, light, and shadow, each transferring multisensorial experiences to the costume designers and creators, as well as the spectators who enjoy the final result in the computer-animated film.

CHAPTER 6

CHAPTER 6

RESEARCH CONCLUSIONS

This study examined the underexplored topic of costume design in the context of Hollywood computer animation, where animators have traditionally been responsible for the design of the character's costumes. The aim of this doctoral research was to investigate the costume designer's role in the pre-established workflow of computer-animated film production, focusing on the impact of their contributions on costume design development and the different ways that digitally animated costumes connect to characters' personalities and narrative. To achieve my research aims, I focused on the work of professional costume designers in six computer-animated films that engaged a costume designer in the film production and were produced in Hollywood between 2001 and 2016. Through the analysis of costumes from these six case study films and the work of the costume designers, this thesis explores the effects of technology development on costume designers' work, as well as the characteristics of the final digitally animated costume, particularly in relation to form, cut, and material. In addition, the study investigated the relationship between tangible and digital materials and the role of tangible materials in digital costume design.

The selected designers and case study films are Isis Mussenden and her costume design for DreamWorks' *Shrek* (2001), *Shrek 2* (2004), and *Puss*

in Boots (2011); Israel Segal and his work on DreamWorks' *Shrek the Third* (2007); Ruth Myers and her costume design on ImageMovers' production *Monster House* (2006); and Danny Flynn's work in Disney's *Big Hero 6* (2014). Through the exploration of these case study films, this thesis provides new perspectives on how costume design evolves as part of character development in films produced by different Hollywood animation studios in relation to both industrial process and film aesthetics. In order to achieve the aims, I formulated one main research question and two sub-questions. The main research question asks**:**

> What are the key characteristics of costume design for digital characters in computer-animated films?

The two sub-questions ask:

> 1. How does the development of technology in computer animation affect the costume design process and the final outcome of the character's digital costume?
>
> 2. In what ways are tangible materials part of digital character costume design?

To answer these research questions, I employed the semi-structured in-depth interview method to collect data, which was beneficial in providing first-hand insights into the costume designer's experiences with computer-animated films. This method was also vital for shedding light on the costume designer's process, which in animation is commonly hidden within the industrial process of making computer-animated films. The data collected for this study emerges as a significant contribution to the fields of costume and animation studies, bringing to light the costume designer's knowledge and experience previously unexplored in these contexts. The visual materials collected during the interviews hailed from the designers' personal archives, such as original costume drawings and fabric swatches, and were thus vital pieces of primary evidence of production phases that typically remain obscure and subsumed by other industrial processes.

My decision on coding and analysing the transcribed interviews with a content analysis method proved fruitful as it enabled me to identify larger thematic areas and a number of linked concepts. These thematic areas relate to collaboration, technology, and materiality and emerged as important strands that helped explain the value of costume designers' involvement in computer-animated film productions and identify key characteristics of digital character costume design. The interviews and subsequent data analysis aided in conveying new viewpoints regarding the inclusion of costume designers in creative teams in the field of animation and in understanding the importance of costume design as an integral part of character development in computer-animated films. These thematic areas and concepts formulated the main findings of this study, explored in Chapters 3, 4, and 5.

Another central analysis to my methodological approach was visual analysis, where I compared a variety of visual materials, such as costume drawings, with audio-visual materials, such as sequences from the case study films. This method enabled a visual analysis of the costume design development within the production of computer-animated films; in other words, an examination of the ideas and solutions related to costume design from the first drawings until the final result, the digital costume. I further compared visual and audio-visual materials with the information acquired from the interview data. Through this careful cross-examination of oral and visual materials, I identified thematic areas related to costume designer's collaborative work processes, the effect of technology development in costume design development and digital creation, as well as issues regarding tangible and digital materiality. Within these thematic areas I made connections between character costumes and scenes in the case study films. This comparative analysis facilitated the identification of the differences and similarities between the costumes in the case study films, and how the costume designer's involvement influenced the character development in the films.

My study followed the typical data-driven research and phenomenological hermeneutic research process of first analysing the data and then contextualising the information provided by the data in relation to theoretical considerations. I chose to connect the theory of somaesthetics (Shusterman 1999, 2006, 2012), the concept of sensory perception (Shusterman), and the concepts of haptic perception and haptic visuality (Marks 2000, 2002) in my discussion as these theories relate to the costume designers' somatic consciousness and embodied feelings, which guided their design development. I also employed selected theories of embodiment in studies

of costume design (Monks 2010) and animation (Crafton 2013) where in my analysis I add to pre-existing writings on animation performance that costume design is an important part of animation acting and performance. Further, I drew from theories on materiality (Ingold 2013; Harris 2013) to better explore the relationship between tangible and digital materials in the context of digital character costume design.

This concluding chapter presents four central ideas that surfaced from my study findings. Through these themes, I formulate answers to my research questions, first discussing the role and essential contribution of the costume designer in pre-established computer-animated film production pipelines. Second, I explore the indistinguishable connection between digital character and costume in reflecting characters' identity, body, and silhouette. I further contend that costume is the chief visual element perceived by the audience, integral to the character. Third, I discuss how costumes in the studied films are visual storytellers of films' evolving narratives, and I reflect critically on how these connections were accomplished in the case study films. Last, I show how costumes in computer-animated films have aimed to depict digitally realistic material, adding to larger debates on how we understand digital realism. In addition, the development of technology has enabled the more complex creation of costumes in their structure, texture, and material behaviour, which connects digitally animated costumes to broader debates around computer graphics and discourses of realism.

In my first central concluding idea, I explore the costume designer's role in collaborative animated filmmaking. My study has demonstrated that costume designers are crucial collaborators in the pre-established computer-animated film production process where many artistic and creative departments work simultaneously. In the case study films examined in this thesis, costume designers were mostly engaged in character and script development. What is distinctive in the collaboration from the costume designer's point of view, is that the costume designers all experienced a consistent, close collaboration with several professionals working in different departments in the film production. Consequently, the final result of costume design was achieved through a collaborative effort working alongside the director, producers, production designer, art director, and scriptwriters.

This research suggests that costume designers can contribute to script development in computer-animated films, where scenes are developed throughout the films' pre-production phase. Costume designers must respond to constant changes in the film's script and rework the designs multiple times, which I propose is one of the characteristics of digital character costume design and part of the collaborative animated filmmaking practise. Based on my case studies, however, the costume designers were engaged with the scriptwriting stage of the production in only one film. This engagement enhances the creation of costumes that reflect a character's action and dialogue in scenes. Costume designers' involvement during the script development phase allows the writers and animators to respond to costume-related ideas quicker, which positively affects the films' production time and budget.

In addition to their expertise on a conceptual and creative level for designing digital character costumes in computer-animated films, costume designers' knowledge is evident in the collaborative industrial process when animators study real garments on a real person in movement. In animated filmmaking, this phase is traditionally referred to as motion study, where the form, construction, and materials of physical costumes are observed and replicated in the animation. In my case study films, the costume designers researched the right type of real garments and passed these on to the animators for study on a physical person. The animators examined the physical qualities of the costume, such as texture, weight, and drape of fabric, especially from a perceptual viewpoint of how real garments appear on a body and respond to human movement. My study has expanded the motion study process further in the context of animation practice by demonstrating its connection to costume design. More specifically, this study proposes that motion study in the production of animated films is closely connected to the somaesthetic and embodied experience of wearing clothes. Physical garment examination by the animators allows them to understand the different kind of feelings that materials transmit. My research suggests that this embodied garment examination can be implemented in the animation production process into phases where characters' different personalities are built and action in scenes developed. The input of a costume designer in these phases is equally important for producing believable acting and helping the animator embody the character via the design of their costume.

This study's findings indicate that, even in the case study films, computer-animated film production lacks input from a costume designer during the critical later phase when costumes are digitally animated. The absence of a costume designer in that phase unfortunately appears to be a common

characteristic of digital character costume design. A challenging aspect of the production process is the exit of costume designers from film productions prior to the creation of the character costumes with animation software. The collaborative dialogue ends before digital animation begins, and as a consequence, costume design–related decisions at this stage are made without the costume designers' expertise. This study proposes that the complexity of digital animation requires engaging costume designers through the phase when digital garments are animated on a character. This critical phase is when physical aspects of a garment, such as material weight and texture are digitally produced. This research, therefore, introduces a potential phase in computer-animated film production allowing inclusion of costume designers to achieve more efficient, productive, collaborative digital costume creation. As costume designers do not typically participate in this phase of animation, I argue for the potential input that costume design could add in this crucial phase of the process. Hence, this production phase offers new avenues for future research.

In my second central concluding idea, I focus on the indistinguishable connection between digital character and costume. In this study, I have established a dialogue between costume (Monks 2010) and animation studies, when digitally animated costumes are built on a character's body and digital characters visually presented to the audience. My study has presented the aspects that create an indistinguishable connection between costume and character. I propose that the lines of the form and construction of a digitally animated costume are created on a character's body as a specific "costume model." This is a term I established while analysing the costumes in the case study films. Because costume design in animation has traditionally been merged with character design development, there existed no specific term to define the costume on the character. The costume model forms the design and structure of a costume, including the details, which make up the character's form and silhouette. Thus, the character's costume and its body remain indistinguishable on a perceptual level. As Crafton (2013) states that the character's silhouette is essential for the recognition of an animated character, my thesis shows that the silhouette is formed by the shape of the costume, which is also the shape of the body, making the design of costume highly important. Hence, the main visual image of the character is defined by its costume, rendering the character's body form and costume indistinguishable from one another.

This connection between character and costume materialises from the costume designer's contribution to improving the visual representation of each character's specific identity. Costume designers enhance the characters' formation of identity through costume via specific materials, costume structures, and colours. Hence, the costumes' visuality reflects the different genres the computer-animated films represent, enabling us to differentiate historical fantasy films such as the *Shrek* franchise from science-fiction films such as *Big Hero 6*. Costume designers' expertise also contributes to connecting the characters with cultural contexts, the film's locations and time periods more accurately. These essential features in costumes visually convey the characters' different personalities and the world within the film. They allow the audience to "read" and recognise the character. When the animated character appears in a scene, the spectator sees the character's costume as the primary visual element. This renders the costume an essential visual element of character representation because it visually represents the character's personal history.

The indistinguishable connection between character and costume can also be observed through embodiment, as costume facilitates ideas for animators to "become" or embody the character. The animator or artist is often understood as the centre of the character's performance and a protagonist for creating the character (Wells 1998; Crafton 2013). I argue that costume design is vital for creating this connection between the animator and character. Monks (2010: 20) remarks when discussing live performance that dressing up in costume is a moment when the actor transforms into the character they are acting. The costume here enables the 'actor to access the world of performance.' I propose that in animation, costume similarly facilitates the animator to "become" the character and the character to perform, through the physical and emotional feeling and experience of wearing a particular costume.

The third central concluding idea explores the narrative potential of digital costume in computer-animated films' storytelling. The story forms one of the most important elements influencing the success of a computer-animated film. Together with other visual indicators of the story, such as the environments, costumes support the narrative developments through colour, texture, design style, and overall aesthetic design, which all contribute to the film's coherent aesthetic design. In my case study films, costumes conveyed narrative clues mostly related to time period and location, such

as the Middle Ages in the 14th century in *Shrek* and *Shrek 2*, the Renaissance period in Spain in *Puss in Boots*, or a futuristic setting in *Big Hero 6*. However, "costume changes" showing visual evidence of change in action, emotion, or dramatic events within the narrative, were employed infrequently when a significant change in the plot occurred (e.g., wedding scenes in *Shrek* and *Shrek 2*), commonly near the end of a film.

Costume changes in my case study films were primarily accomplished by re-using the character's own costume model. The appearance of a "new" costume was created by altering the colours and fabric textures on the same costume model. Computer animation software development enhanced the reproduction of real material textures, colours, light, and shine, producing visible differences between costumes when the character costume changes were made by re-using the costume models. These specific costume models served a character within a film and across films, such as the *Shrek* franchise, and costume changes were minimal. From this finding, I add to the existing literature on animated characters' silhouettes that have been developed within scholarship on animated acting and performance (Crafton 2013). I argue that re-using the specific virtual costume models to create a costume change establishes a specific distinguishable look for the characters and their silhouettes, which is an important factor for animated character definition.

As the case study films rarely employed costume changes, many costumes were not used to support changes in character's emotion, action in scenes, or the mise-en-scène. My research indicates that it would have been more complicated and time consuming to create the costume models than to simply change the colours and textures on the costumes. However, more substantive costume changes would have provided stronger visual support for emotional and narrative changes. Examining my case studies, it appears that these benefits were either not considered or not valued. The only film employing costume changes more than twice was *Shrek the Third,* and in so doing, these changes added value to the entire storytelling and strengthened specific action and emotion in scenes by certain colouring and textures in costumes. Unfortunately, none of my case study films used the full narrative potential of costume. This element offers another research area to investigate and an industrial phase to consider in the production of computer-animated films.

Another important support for narrative development is ageing and any visual evidence from physical activity on costumes that were lacking in the studied film costumes. Similar to altering colour and textures on costumes via animation software, signs of physical activity such as stains or marks of wear in fabric textures can be added in costumes to increase the believability of a performance and connect the characters with the action in scenes. My investigation found this type of alteration to digital costumes to be economical and not labour intensive, and it would increase the characters' connection with narrative changes. However, such visual effects were rarely added to costumes in order to reflect action, emotion, or a character's lived life. This brings to the fore another area to consider in future computer-animated films: inclusion of more detailed costume surface textures, ageing, dirt, and stains that evolve during the film's narrative development. Costumes are active agents and visual storytellers in which details from physical activity add value through tactility to the character's visual representation, improving the audience's experience of the film and its characters.

Last, the fourth important conclusion of my thesis surrounds implications on novel ways of thinking about digital realism. In my work, digital realism refers to how accurately the digitally animated costumes and their materials depict their real-world referents, where truthful character acting and costume behaviour are primary goals. Digital realism hinges on how believably the digital costume materials depict surfaces, three-dimensional textures, colours, light, and shade. In addition, the digital reproduction of the elements of realistic cloth behaviour, i.e., the ways it falls on a body and reacts to human movement, is essential for animating digital costumes. Creating these aspects of realism successfully in digital costumes is two-pronged: it is an experience for the makers, the designers and animators, and their creation is an experience for the audience.

My study showed that tangible material exploration is connected with somaesthetic practice in which the costume designers' and animators' personal somatic feelings guide the design development and the creation of digital costumes. Exploring materials through touch offers an expanded transfer of information to the costume designers and animators regarding the feeling of the texture (e.g., rough, smooth, soft). The feelings that materials transfer to the body lead to design ideas that are then interpreted in the digital character costume designs and the digital reproduction of the material. Costume designers' personal experiences through touching and

feeling the material samples during the costume design development is a somaesthetic practice. The somaesthetic exploration guides the designers and animators in their work processes and enables the costumes to appear as something identifiable and digitally realistic in computer-animated films. These aforementioned results connect to my third research question regarding the role of tangible materials in digital character costume design.

The creation of digitally realistic costumes in the computer-animated films that served as case studies for my research was influenced by the development of technology and was evident in three direct ways. First, software development enabled more complex creation of costume models making possible more intricate costume designs in their structure and details. Second, software development enabled the costume materials to behave more realistically, making the costumes more authentic in their re-production of real-life examples, and corresponding to specific design features that depicted ideas of certain time periods. Third, software digitally constructed the complex layers of costume materials developed through the course of time. This was visible in the depiction of material characteristics, including depth, texture, light, and shadow that improved gradually from film to film. Technology development has also allowed recent computer animations to benefit even more from advanced computer animation software than the case study films, which means that these films are technologically capable of creating digitally realistic costumes.

Digitally realistic costumes are also an experience for the audience. Digitally realistic costumes involve truthful cloth behaviour, depiction of real-world textures, connection with the character's personality, film's story, and action in scenes. These altogether are vital for improving the audience's experience of watching computer-animated films. To highlight this in my analysis, I have intertwined Marks (2000, 2002) and Shusterman's (e.g., 1999, 2006) studies on sensory and haptic perception to show that digital costumes are powerful in transferring multisensorial experiences and enabling audience immersion in the world of a film. They enhance the spectators' ability to experience characters' feelings, which means that sight is engaged with other bodily senses such as touch and feel. The experience of looking enables the audience to feel different costume material qualities, such as softness or roughness, without physical touch. These observations add to the previous discussion of what Prince (1996) calls 'perceptual realism' by arguing that costumes are important elements that offer new ways to think about digital realism. Digitally realistic costumes are re-productions of real-life examples. However, I argue that digital costumes can go beyond realism and correspond to what Wells (1998) argues – that animation pushes the boundaries of the real world and defies gravity. There is potential in digital costumes to offer broader options that are impossible to produce in tangible real-life costumes. Digital costumes can comprise materials and behaviours that are not possible to produce or use, or that do not function in real life, which is a noteworthy aspect to consider in future computer-animated film production processes.

To conclude, this thesis has demonstrated the different ways that costume designers are important collaborators in computer-animated film productions and that costumes are visual support for creating and crafting a character's fictional history, identity, and place within the world of the film. This study presents the key characteristics of digital character costume design across a number of popular computer-animated films; however, it also highlights new questions and areas to research further. I have brought forward new lines of enquiry in costume and animation studies; the results of this thesis stand as groundwork for future investigations in digital character costume design. In the following sections, I discuss the limitations of this study and finish with a return to the conclusions and areas for further research and implications in computer-animated film productions.

6.1 Limitations of the study

Some limitations must be noted as part of this doctoral research study. In qualitative research, evaluation of study limitations and reliability is necessary (Creswell 2013). For research to be reliable, it involves transparent practices of data collection and management (Creswell 2013), which I have performed throughout my research process. In my work, limitations occurred when I was denied access to the archives at the Walt Disney Animation Studio and not able to obtain oral statements from the professionals at the DreamWorks animation studio. To cover this gap in data, I collected my materials from design professionals who worked outside these companies. This proved useful as I was able to interview the costume designers who worked on the case study films and to gain valuable visual materials from their personal archives. Despite the restricted access to the specific studios, I was able to collect significant amounts of data to analyse and successfully ex-

plore costume design in the case study films in depth. I also succeeded in accomplishing my research across animation studios and genres.

Potentially a limitation, but also an asset is my professional costume design experience. I have acknowledged my position transparently throughout the research process and analysis. Although I share similar professional experiences with the key study respondents in relation to the process and development of costume design, I have never been involved in the animation field as a professional designer. Therefore, my lived experiences encompass different production processes than animation, and I have been working with real actors and bodies, not digital ones. This causes possible limitations by my not having considered all areas and aspects involved in digital character creation and animated filmmaking. For example, I lack practical understanding in creating an animated character's performance and the construction of digital costumes on the characters' bodies. A possibility exists that I missed a stage or production phase connected to costume design due to my experience from outside the animation field. My background, however, contributes to unique interdisciplinary research allowing me to integrate my personal knowledge and academic studies from the field of costume design to study costume design in the context of animation.

Another limitation relates to time. When I started this research study in 2016, fifteen years had passed since the release of the case study film *Shrek*. Therefore, some of the experiences in Isis Mussenden's costume design development in this film as well as in *Shrek 2* might have faded somewhat. Given that she has since then worked on numerous other projects, a full and accurate recollection of all the details of her work on those particular animated films may not have been possible. Similarly, with other designers, Flynn, Segal, and Myers, between five to ten years had passed since they worked on those animated films. Experiences fade and transform into more general concepts rather than specific details. To avoid missing information in the data, I asked specific interview questions and encouraged the designers to explore visual materials from their costume design development to assist in accurate recollection of their design process. The visual materials, drawings, and written notes assisted the designers to recall their design process; hence, all materials together were vital to produce comprehensive and valid research data.

Last, the visual materials saved by costume designers after working on the case study films varied. This causes limitations for two areas of this research. First, costume designers' ability to elaborate with more detailed experiences regarding their costume design is limited because not everyone had an equal number of visual materials to explore while discussing their work. Second, I could not always compare the same materials between each designer in my comparative visual analysis. For example, Myers had retained only a few of her final costume drawings and some photos of the garment examples she provided to the animators for digital animation. On the other hand, Mussenden and Segal had saved most of their costume designs, costume development drawings, visual materials, and tangible materials samples. In contrast, Flynn's personal drawings are kept at the Disney Animation Studio. He owns only the book including visual materials that he presented at Disney when he applied for the costume designer position. However, a large part of his costume design development consisted of exploring real garments that he owns at his Replika Vintage clothing store. In his case, he showed these garment references while discussing his work process in *Big Hero 6*. The cross-examination and comparison of visual materials was therefore based on the availability of different material sources.

6.2 Setting up the future: Return to research ideas and implications of this study for the animation industry

This thesis has shown the importance of a costume designer as an active collaborative professional in computer-animated filmmaking, and the value of costume design for digital characters' visual representation. My study presents insights into the practices and theories of digital character costume design and can provide groundwork for other scholars in future studies, prompt further research ideas, and effect new animation practises within the industry. In this final section, I first explore ideas for further scholarly research and thereafter present the implications of this thesis for the animation industry, specifically suggesting novel ways of developing characters and their costumes.

In costume design scholarship, costumes are considered as highly material, understood through certain textures, forms, and as physical entities that are placed on a body. Costumes connect with the real-world experienc-

es of wearing garments. When turning the discussion to digitally animated costumes, with no real garment nor physical body underneath, new ideas for future debates can be offered to the ontology of costume. As indicated in my thesis, digital character costumes find form from costume models whose shape creates the outline of the character and its body. Thus, costume does not need a physical body underneath in order to be used and presented. My research expands the notion of what constitutes a costume; however, ideas for further research include a focus on digital costume and body.

This study has focused on costume designers' experiences as part of collaborative animated filmmaking, demonstrating that costume design is closely linked with the creation of a character's performance. I have intertwined Crafton's (2013) ideas of character performance and animators' acting; however, these studies fail to consider the essential role of costume as part of character animation. What remains relatively unknown are the different experiences that costumes transmit to the animator (as the actor) in creating the character performance. It is important to further explore insights from animators regarding how character performance is developed and to better understand the embodied experience that costume transfers to animation acting. I also propose that somaesthetics offers a theoretical lens to examine the embodied effects that costume transfers in animation acting and performance. Examination of the ways that elements of materials, such as weight, texture, flow, and touch affect the animator's choices for character costumes can be a focal point for future research. An additional point to investigate from a somaesthetical point of view is costume's effect on dialogue and performance.

My thesis has shown some parallels between the different phases and processes of designing computer-animated costumes with costume design in hand-drawn and stop-motion animation. Further investigation is required to deeper engage with these forms of animation in the context of costume design. Another research idea for future investigation centres on materials and texture in stop-motion animation where costumes on the puppets are created with physical materials and often by hand. Next, I focus on the implications of my study on industry practise; many of these ideas also call for further scholarly investigation.

Within the animation industry, multidisciplinary collaboration is essential, and my research has revealed the phases where costume designers have acted as important collaborators within the animation production pipeline.

In this process, the costume designers' professional knowledge enhances the quality of the animated costumes and the films' success. My study demonstrates the importance of increasing the interdisciplinary collaboration during the period when the digital costumes are built on characters' bodies with animation software. What remains unknown are details surrounding the process of creating digital costumes because the costume designers were no longer engaged at this stage of the production in the case study films. However, during the digital costume creation, decisions are still made regarding garment construction and design solutions, which are important factors for characters' visual representation and connection with the narrative. Deeper engagement with a professional costume designer during the phase when character costumes are digitally made leads to better collaborative filmmaking practice. In the cases where this is not possible, equally important is to then engage other creative personnel (e.g., a visual development artist or a character designer) in the films with specific focus on the development of the characters' costumes. This ensures that they oversee the important costume design approach where characters' visual appearance connects with the world of the film. As my thesis has shown, *costume design* and *costume designer* are equally important in computer-animated filmmaking.

Costume designers' collaborative practice could be further investigated and considered in the animation industry from the stage of script development. Similar to scholarly perspectives on animation acting and performance, the viewpoint of costume design opens new perspectives to discover costume-related ideas for performance in computer-animated film scenes. Through the costume designer's expertise, entire scenes can be developed so that the driving force of the action is steered by costumes. Furthermore, in relation to script development, the examples presented in this thesis are evidence that costume design fails to be used sufficiently as a visual dramaturgical tool in presenting changes in narrative. Costume design is important for storytelling and character representation: the power of costume should not be undervalued but taken as an asset and essential part of character and film development in future computer-animated films. Animation software has developed sufficiently to support an increase in the number of costume changes in films. When costumes reflect more of the action, emotion, and dramatic changes in scenes, the characters become more strongly connected within the narrative. Technology supports the potential to increase the level and number of narrative clues in costume design; for

this, I propose that the industry can take further into consideration costume ideas in computer-animated film productions.

The rigorous reproduction of real-world material elements into digitally realistic costumes constrains creative, imaginative costume ideas – costumes that would defy the laws of the real world. Computer animation offers an opportunity to build unrealistic and imaginative costume designs and impossible structures not based on real life. Imaginative textures and material behaviours, for example, could be employed in building comedic ideas in specific scenes or entire narrative development. As the examination of the case studies suggests, this is not implemented enough in costume design for computer-animated films until today/in current production. Collaborating with costume designers during the script development and in the phase of digitally animating costumes brings specialist knowledge into these processes and enhances digital creativity in costumes. This is especially achievable in contemporary animation due to the latest developments in animation software. My thesis has expanded ideas surrounding digital realism to digitally realistic costumes where these theories and ideas regarding digital representation of costumes can also be employed in studying costumes in gaming and special effects, where costumes are also digitally created entities. Also, in gaming and live-action filming where costumes are digitally rendered, costume's imaginative, creative possibilities can be considered.

In the five-year period during which I conducted this doctoral study, the majority of the computer-animated films in Hollywood were still produced without a costume designer's input. Pixar's *Incredibles 2* (2018) stands as the only computer animation that credited and acknowledged Deanna Marsigliese as the character and costume designer, working in the Animation Department. However, due to the popularity of recent computer animations such as *Incredibles 2* and *Frozen 2*, the recognition of costume designer and importance of costume design in animation is gradually growing.

Marsigliese's contribution to the mid-century modern style in *Incredibles 2*'s costumes and continuation of the pre-established look of the superhero characters in the film are discussed online in popular media, such as in the blog posts by Mock (2018) and Perrin (2018). Some ideas behind the processes and outcomes of Marsigliese's mid-century modern costume designs are also presented on Disney's (2018) website. An important American mainstream media such as *The New York Times* (Ito 2019) dedicated an article to the topic of costume design as part of the release of Disney's *Frozen 2*.

My research has also drawn the attention of Ito (2019) who noted that 'in academia, scholars like Maarit Kalmakurki are writing about the importance and expanding roles of costume designers in the animation industry.' This suggests that my research has influenced the growth of discussion regarding costume design in animation. These articles and the media attention demonstrate that costume design has been presented as an important focal point when discussing new films.

Ito's (2019) article title *Anna, Elsa and the Costume Designers Who Create Their Looks* suggests that the film actually hired and credited costume designers; however, the recognition for costume design for *Frozen 2*'s lead characters (Anna and Elsa) is given to visual development artists Brittney Lee and Griselda Sastrawinata-Lemay and not to any costume designer. *Vox Media* (Bryant 2019) continued a similar discussion, which shows continued uncertainty on how to address the professional title and the process of costume design connected to animated character development. While I was making the final edits to this thesis, to my surprise, a job advertisement for the position of "costume designer" appeared online on the Disney Careers web page. The advertisement points out that costume designers collaborate with the production designer and art director, but also with departments that create digital modelling and cloth simulation. In this thesis, I proposed more collaboration with costume designer across the departments and this job advertisement suggests that this has been considered at Disney. The advertisement also marks that costume designers provide research on construction and detail on material texture, weight, and movement – all areas that I had noted and analysed in depth in this thesis.[59] However, it remains to be seen if the work of these costume designers will be acknowledged by Disney in their future films.

These recent and future computer-animated films offer new materials and thus sources for scholarly research to further examine costume designers' contributions to the design of character costumes and the extent to

[59] I cannot add a link to the job advertisement because it was removed from the web page at the end of the application period. An additional description of the job title was that costume designers provide 'wardrobe designs that will reflect and accentuate the personalities of the characters wearing them as well as facilitate a wide range of character performance and movement.' This suggests that character performance and movement are considered as important areas of costume design, something that my thesis also highlighted. However, what is unclear is whether costume designers work alongside the animators who create the character performance.

which costumes improve the representation, imagination, and truthfulness of the characters in film. These films can also be examined from the viewpoint of audience reception. From this thesis emerges a set of ideas and theories to support the growth and recognition of costume design in animation, to analyse costume design further, and to raise more awareness of costume design in animation, which is vital to characters' representation and to computer-animated films' narratives.

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APPENDICES

Appendix 1: Interview Questions

The questions were revised for each designer to discuss specifically for the film they worked on.

General Questions

Where did you grow up?
What were your interests when you were a child?
What is your academic background?
How many years have you been working as a costume designer for the film and television/ entertainment industry?
What was your first production and how did you get that job?
(for Isis Mussenden) Had you read the book Shrek! by William Steig before you were employed on the film?
How did you get the job as a costume designer in (film name)?
Was it a previous collaboration with the director, knowing someone in the production company, etc.?
What was your job title in the film Shrek?
When did you start pre-production on the film?
What date was your work completed on Shrek?
How much time was there between when you completed your work and the wrap of the production?
How much time there was between the wrap of the production and the release?
Have you worked with the (film name) director before?
Have you worked with the writers before?
Have you worked with the animators before?
Did you have any relationship with the voice characters before the film pre-production?
What were your normal working hours? Did they vary in different stages of the production?
Were you included in the press release and the interviews for the DVD?

Did you receive compensation or credit for your designs for any of the (film name) merchandizing?
Do you know any costume designers who have worked in 2D-animated films prior your work?

Pre-production
Did you meet with the director before you read the script?
If yes, did they clarify/explain their visions for the design of the film?
When you read the script, did the director's idea match with your concept of the story?
How differently did the director work in this animated film (relating to costume design) compared to previous films and other directors you have worked with?
Was your research strategy for Shrek any different than when researching for period live-action film? How was it different and how was it the same?
Where did you do your research?
Did DreamWorks have a research library and a librarian to help you?
Had you ever designed a film that took place in the (time period)?
How did you choose which medieval costume elements to include in the costumes? Which elements did you not choose and why?
Were there any costume elements that you wanted to include that you had to fight for?
Did a storyboard exist when you started working on the film?
Were you involved in the character design?
Did the characters already exist when you began your design process?
Did animators / character designers accept your work on the film? Were you embraced or questioned?
Describe the general duties and areas of responsibility on this film?
- this probably leads to sub-questions.

In costume design for Shrek, can you describe any challenges you faced? Can you address any of them?
When designing costumes for animated characters in Shrek, did the characters' (body shape, form) already exist before you began your design process?
Did animated characters' different body shapes and forms affect the costume design process? Example, did they bring more creativity, bring restrictions, advantages?

Complementary questions
Who were the people you collaborated the most with in the pre-production process?
Did you use any of computer software in the design process?
If yes, were you familiar with the software?
If yes, was it helpful to your design process?
If no, did you think that you would have needed to use it?
How did the lack of technology influence / affect your costume designs in the first Shrek film?
How often did you meet with the animators / character designers?
What kind of material did you provide to the animators as costume references?
Was it similar material / swatches to what you normally provide in a traditionally filmed movie?
In your costume design process, can you describe the most significant issues faced due to technology?
Did you feel that the final "look" of the film captured what you and the other filmmakers tried to achieve?

GLOSSARY

Art direction
The foundation and visual direction of the aesthetic style of an animated film. Art direction is often visually depicted via concept art.

CGI
The abbreviation of the term "computer-generated imagery," used to refer to digital objects and graphics that are created via computer software. Also referred to CG.

Character animation
The stage in animation production when animators develop character poses, facial expressions, and movement.

Character design
Visual conceptual design of a character.

Character development
The phase when a character's overall visual and psychological appearances are created, such as the body type, face, and hair, and how these all connect to their personality and the world of the film.

Character performance
The phase in character development where the character's movement and performance are created and delivered.

Concept art
Artistic designs that depict ideas for the animated film's visual aesthetic design.

Costume design development
Part of character development where ideas for costumes are explored in parallel to the development of character's overall visual and psychological appearance.

Costume drawing
Drawn example of a costume design that can be a quickly drawn sketch or more developed drawing. Costume drawings can include written commentary and material samples.

Costume model
Definitive term for a digitally animated character's costume structure and silhouette.

Maquette
A three-dimensional clay sculpture of an animated character.

Modelling
A phase when characters, environments, and props are digitally built.

Motion capture
Also referred to as Mocap, a digital recording technique that captures and represents human movement.

Motion studies
The phase in animation where animators study a real person in movement in order to animate it authentically.

Parti-colouring
A design where half of a garment, or one quarter, is made in one colour and the other in a different colour. This fashion style is related to the Middle Ages (esp. 14th and 15th cent.).

Period costume
Costume design that visually depicts fashions from a specific time.

Pre-production
The phase in an animated film production when art direction, character design, story, and scenes are created.

Rotoscoping
A technique where animators trace live-action footage to produce realistic performance.

Silhouette
The shape of an animated character's figure which is important for character recognition.

Storyboard
A series of drawn film sequences that illustrate the action in scenes, which depicts the film's narrative.

Visual development
Another term for character development, sometimes used in animated film production schedule.

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This pioneering study brings attention to the role of costume design in animation. It explores how digitally animated costumes are designed through six exceptional computer-animated film productions that engaged a costume designer (*Shrek*, *Shrek 2*, *Shrek the Third*, *Puss in Boots*, *Monster House*, *Big Hero 6*). Little is known of the stages involved in costume design for animated character identities and storytelling, since traditionally in animation, character costumes are designed by an animator and decision-making has been subsumed within the character development process. This monograph explores the collaborative effects of costume designers in animated films and illuminates the different ways the medium of computer animation affects design decisions and costume material choices. Although the final result is digital, tangible materials play an essential role in costume design development and creation. These digital character costumes are powerful in transferring multisensorial effects to the audience, enhancing character believability and audience immersion in the world of the film.

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