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Realism in CGI Character Performance:

A Comparative Study of the Evolution of Key-Framed Animation and Motion Capture
Systems at Weta Digital Studios

Preface

It seems that animation is an ever-changing art form which is constantly affected by the development of graphics technology, which is the reason why I, a student of animation and animation research, became interested in the topic of the development of key-framed and motion capture animation techniques. There has been a high demand for the development of animation technology, specifically for the purpose of recreating *realistic* cinematic film, or animation closely related to and following the conventions of live-action film. For over a century, animation has become a largely successful medium in which imaginative, fantastical characters and worlds can defy the physical laws of nature and provide narrative, which is difficult to meet via other cinematic mediums. This phenomena is largely successful due to the ability to stretch the medium and narrative concept beyond reality. Inevitably, the question arises as to why the medium often aspires towards *realism* or replicating a live-action approach. Is the notion of *realism* necessary in animation narrative?

Since the early stages of animation, new ways of telling stories forced animation

technology to develop in order to endure the challenging demands of creating original narratives. It was during these early stages that rotoscoping, a technique in which the animator would trace live-action footage onto paper, became the most advanced method in which to mimic realistic movement in animation. The concept and technology of this method soon evolved along with contemporary cinema into motion capture, a system in which markers are placed on a body and transferred to computer via numerous marker-detecting cameras positioned around the figure. In effect, this technology, like rotoscoping, allows for the figure to be “traced” from real life. However, the purely motion captured results have not matched the quality of polished key-framed animation. It is common for studios to hire both motion capture technicians as well as animation teams in order to create a more appealing combined result. I previously completed a thesis on the topic of the controversial debate between motion capture and animation, in which I became interested in the tension between the manual transcription and the creative freedom of animation. I discovered that although motion capture has developed significantly, it has not always been met with positive response, specifically for its purpose to create more *realistic* performances in animation. This has been especially true for motion capture used in fully animated film, however, cinema has evolved in such a way that some live-action films have come to rely on animation for storytelling.

The change in the conventions of cinema has also seen the necessity for realistic animation, as the modern live-action science fiction, fantasy and action genre has become more reliant on animation for its narrative. Here, the line between live-action and animation has often become blurred in the pursuit for a film that is neither purely live-action nor purely animation. It has recently branched off into a new style known as

'special effects animation'. Fusing two completely different mediums into one film has meant that it has had to adapt in order to make the live-action/animation hybrid feel more comfortable. It is here that realism seems necessary, however, the pursuit for realism has also frequently been utilised in fully animated film, which could be argued to be unnecessary.

The topic of realism has been long debated upon, proving to be a complicated term when related to animation. The exploration of the relationship between key-framed animation and computer performance capture, which results in the investigation of the pursuit of realistic animation, is a fairly young subject in the animation industry. Scholarly works on the subject have only appeared approximately within the last two decades, along with the development of computer graphics technology. While numerous works written on the subject of realism in animation, such as Paul Wells' *Understanding Animation*, and Richard Wages et al.'s *How Realistic is Realism? Considerations on the Aesthetics of Computer Games* (research done on the response of test subjects to realistic models and how it applies to animated realism) have provided me with endless insight as to why there is a great desire for realism in animation, there are not as many articles that explore its relationship to motion capture technology and its development in modern cinema. I have discovered one main resource on the topic, an article written by Gray Hodgkinson called *The Seduction of Realism*, in which much can be gathered about contemporary computer animation and its tendencies towards realism. It is at this point that it was made clear that there were further dangers facing the hunt for realism, namely the *Uncanny Valley* theory, a hypothesis written by roboticist Masahiro Mori, which indicates a person's negative reaction in the presence of a realistic human-like robot. This theory has often been

made relevant to animation and I have found it to be significant in the discussion of contemporary computer animation.

Apart from the articles found relating to realism and motion capture, I was fortunate enough to spend some time with David Bennett, who worked as part of the facial animation team of *Avatar* (James Cameron 2009) at Weta Digital Studios. Bennett lead me through the process of motion captured performance and animation for *Avatar* and provided me with answers as to why these systems were used and why modern cinema pursued realistic animation despite the dangers of the *Uncanny Valley*.

I would like to explore both the relationship between key-framed animation and motion capture, as well as the fusion of the two techniques in modern cinema. Also, due to motion capture's ability to create realism, I would like to investigate the reasons for the struggle to achieve absolute realism/naturalism in contemporary computer animation.

Chapter 1: An introduction to Motion Capture

With the birth of the rotoscoping technique, came the desire to pursue life-like and *realistic* motion in animation. At the time, animators were exploring rules and conventions that could be used to create movement that was believable to audiences and thus the principles of animation were born. However, despite the success of the new medium of animation, techniques such as rotoscoping (a technique in which an animator would trace over live action to create realistic animation) were still created and practiced in the pursuit of *life-like* movement. Since its creation, there has been a particularly contentious debate on whether the technique can be considered as “*genuine animation*” or not. As time passed, these debates extended to newer forms of technology and techniques applying to animation, such as the introduction of Motion Capture (also known as “MoCap”) to computer generated animation.

1.1. Definition of Motion Capture and Key-framed Animation

Before the subject of traditional key-framed animation can be compared to Motion Capture, a technical definition should be provided for each term. Many definitions have been provided for the term “animation”. Paul Wells, author of “*Understanding Animation*”, states that the word “*animate*” is derived from the Latin word meaning 'to give life to'. His standard technical definition explains that animation is a hand-made film, drawn frame by frame to create the illusion of movement (Wells 10). Many other definitions have been provided from sites such as Apple Inc. and Inner Esteem Motion Capture Studios, which hold a similar view to the technical description

of animation by Paul Wells. They describe animation as the illusion of movement, where a collection of images containing small changes within its content plays rapidly in sequence, fooling the human eye into seeing movement and performance (“Apple Inc.” 2008; “Inner Esteem” 2006). The definition of Motion Capture, despite technological changes, remains almost identical to the definition of animation. Inner Esteem describes motion capture as being recorded data from human movement through the use of tiny motion sensors (wireless, magnetic or optical systems) which is in turn brought into a computer where a 3D character can be overlaid onto the sensed data (“Inner Esteem” 2006). Overall, the final outcome of the films using both techniques is identical aesthetically and at a shallow glance one will not differentiate between the two.

Although the outcome of traditional CGI key-framed animation and motion capture may appear to be similar, it is the process that differs. The development of believable representation in animation has included CGI key-frame animators designing sets of formulae and rules that can be applied to a character in order to recreate life-like performances. Despite these notable results achieved by the former, motion capture systems have consequently been set up with the intention of introducing the factor of “*realism*” into animation. The term realism has proven to be a broad and complicated term when referring to film and animation. When discussing realism, Wells often refers to Walt Disney films, stating that Disney insisted on a level of *verisimilitude* in his characters (Wells 23). The word 'verisimilitude' comes from the Latin words *verum*, meaning *truth*, and *similus*, meaning *similar*. Therefore, the word verisimilitude is the likeness or resemblance of the truth – the quality of *realism* in something such as a film or piece of literature.

1.2. Introduction of Realism in Animation

When defining the word *realism* in animation, Wells refers to animated characters moving like real characters, being “informed by a plausible motivation” (Wells 23). Paul Wells, Frank Thomas and Ollie Johnston, authors of the book *The Illusion of Life: Disney Animation*, all agree that in order to sustain an audience's attention for the length of a feature film, one could not rely on gags to carry the narrative through (Wells 24; Thomas & Johnston 81). Ben Sharpsteen, who worked at the Disney Studio, speculated that the secret to Disney's success was due to the element of *realism* added to each film. From his own experience, Sharpsteen found that audiences could not understand or relate to some of the material in the cartoon films that Disney was creating and therefore they needed to be drawn into the “caricature” of realism where situations were clear and plausible and personalities could be related to personally (Thomas & Johnston 81).

Although the term *realism* is still a debatable topic in many discussions regarding animation, it is clear from the arguments stated previously in this essay that despite the subject causing much contention within the animation community, the concept of *realism* is still largely pursued in animated film. Hence the introduction of motion capture systems to create realistic movement. Motion capture, with its ability to record data straight into the animation window, became the ideal tool to create 'realistic' motion in animation. With this tool, it became easier to record timing, proportion and subtle movement, which often proved to be a challenge in CGI key-framed animation. Motion capture not only has the ability to record subtle facial movements, which in

itself is a difficult task in key-framed animation, but also subtle hand movements. Maureen Furniss, an animation scholar, cites Shane Cooper, who argues, "People are very critical of facial animation in terms of sensing the 'realism' of a character. Though audiences are perhaps not as critical about the hands of character, nonetheless these appendages are very important to the animation process..." (Furniss n.p.). This is where motion capture has proved beneficial to the art of animation: facial animation.

Facial expression can be considered the most expressive tool of performance, as it can convey the most information using the slightest variation in expression in the face. In animation, the face becomes the most complex section of character performance, as there are countless subtleties that need to be taken into consideration for an animator to express a believable performance. To a certain extent, animators have been successful in creating sets of formulae and techniques that can be applied to a character, which allows the performance of their characters to achieve a level of reality in their movement. However, the most difficult, yet one of the most important elements of character animation, is the realistic interpretation of facial expression, in which key-framed animation has found some trouble creating accurately.

Motion capture was introduced to film, allowing for the realistic interpretation and representation of animated movement. Its advantage did not only include the accuracy of timing and performance of the human body, but also allowed for the study of subtle movements created by the facial muscles, which is important as it is the accuracy of facial expressions which allows for emotion to be conveyed and understood correctly within the narrative flow. This was shortly followed by the improvement of facial animation and lip sync. Despite the achievements of motion capture, the concept

of requiring the characters to appear to perform in a realistic manner is exactly why traditional animators refute the notion of motion capture. It is argued that the “magic” of animation arises from the ability to do what live action cannot do, so it deviates from reality purposely. Motion capture is considered limited in terms of the principles of animation, such as the lack of physical laws, anticipation and reaction emphasis, exaggeration and the classic 'squash and stretch', which cannot be mimicked by a human performer in motion capture without special editing afterward. In fact, nearly all animated or 'cartoon-like' characters are much more difficult to create using the motion capture system.

1.3. Introduction to the Uncanny Valley

Besides the belief that motion capture is limiting to animation, many critics foresee another interesting problem in pursuing realistic motion. The roboticist, Masahiro Mori, designed a graph to describe the feeling of an unease that a viewer experiences when encountering human-like robots. She termed the theory the *Uncanny Valley*. Essentially, the theory explains that the more realistically human-like a robot appears, the greater the feeling of unease it creates to its viewers. Since the theory's use in robotics, it has also been found applicable to animation in which realism of animated characters has been attempted. In the same way that viewers felt uncomfortable with almost-human robots, they often felt perturbed by realistically animated characters.

There is a great awareness in the professional animation industry of the Uncanny Valley, and animators are conscious of the theory and the danger it implies at pursuing realism in animation. This ultimately creates a paradox in realistic animation, as

animators knowingly construct unappealing characters in the hope of achieving realism. This raises many questions concerning the motives of pursuing such a quest: Will audiences always feel uneasy about realistically animated characters because they know the characters are not real or part of the real world? Does technology have the ability to reach this level of realism? If it has, is it necessary to pursue such high levels of realism where live actors could have been used? For what reasons would realistic animation be chosen over live actors? Is Motion Capture the tool needed to *improve* animation?

Motion capture (“MoCap”) has certainly enhanced animation performance, especially of the face, in terms of creating accuracy in timing, proportion and controlling subtle movements. However, I do not believe that motion capture as an animation tool achieves enough on its own. Practiced animation techniques and principles are still needed to create a good facial animated performance, despite how it may affect the levels of realism within the character. Furthermore, I would argue that the level of realism necessary for animation directly corresponds to the type of film being made (i.e. Fully animated vs. special effects in live-action).

Chapter 2: Motion Capture vs. Key-Framed Animation

2.1. The Origins of Motion Capture

Animation in feature film has existed since the early twentieth century with Quirino Cristiani's creation of *El Apóstol* (1917), which soon developed into a more commercial industry with Disney's creation of *Snow White and the Seven Dwarves* (1937). It was during this time that Disney speculated that the use of more realistic characters, or characters with *verisimilitude*, were necessary in order to hold an audience's attention for the length of the film and therefore began the pursuit for realism in animation. Many techniques were developed in order to record performance data from real life so that animators could replicate realistic movement. One such method was a technique called *rotoscoping*, an invention of animator Max Fleischer, in which live action footage would be filmed and then traced onto frosted glass, creating a realistically moving picture or character. By this point in time, however, animation had already begun to establish its own formulae towards creating believable characters and events, and the introduction of the rotoscoping technique was often seen in a negative light. It had been viewed as a shortcut and a false representation of what animation was.

Many, like Dr Norman Badler of the Centre for Human Modelling and Simulation, argue that motion capture is rotoscoping's natural heir, because both rely on human performance and this human performance is overlaid with the artist's animated character. He considers motion capture to simply be a 3D version of rotoscoping (Furniss np). Michael Barrier argues that motion capture, "which is really a sophisticated form of rotoscoping", fails in the way that its predecessor did by making the movements seem random. Animators control the performance and movement, because they have a sense of which performance is important for the audience to see and which might be superfluous (Barrier; 2009)

Inevitably, when motion capture was introduced much later into CG (Computer Generated) key-framed animation, it suffered the same contentious debate. Like rotoscoping, motion capture was compared to more traditional methods of key-framed animation, a widely used and popular medium in modern film, advertising and graphics industries. Since the introduction of CG key-framed animation, certain animators and digital animation companies have strived for methods in which to create realistic animation and characters, and motion capture seemed like the next logical step in doing so (Bennett 2011).

2.2. The Motion Capture Debate

The introduction of motion capture had caused controversial tension between what could be considered as *genuine* animation and what was considered by most critics as a simple recording of data. Maureen Furniss, a published animation scholar, states in her article on motion capture:

Most agree that the term motion capture already has a negative connotation. In a way, I see motion capture being in a similar situation to limited animation, which also has been derided in terms of its aesthetics. Like rotoscoping, limited animation and motion capture are seen as "technical cheats," to use the words of Greg Pair, of AMPnyc. He notes that the same stigma attacked CGI when it first appeared, but he thinks, "when technology and output improves, motion capture will be seen as yet another new medium and not a replacement for the traditional media." He also suggests that some of the disdain for motion capture stems from a fear of losing jobs to this technology (Furniss; np)

Furniss' view on motion capture suggests that development of motion capture has simply become another tool of animation and another new advancement in animation technology. For the most part, motion capture was mainly used as a reference for animation, in the way that animators could record accurate performance and subtleties within the human movement and then tweak it later using more traditional animation principles. In many cases, the use of motion capture increased to a level in which a film would consist almost entirely of motion capture and very little key-framed animation. Despite the very similar product produced by both forms of animation, cases such as these fired up a heated debate on whether motion capture has improved animation performance or whether it has become a technical 'cheat'.

2.3. The Advantages and Disadvantages of Motion Capture

Both sides of the debate convey convincing arguments. Motion capture is argued to be more time effective, using less labour, and can replicate a performance, movement

or structure accurately. Motion capture also has the ability to capture secondary movement and overlap accurately, principles of animation that take a vast amount of skill and practice to accomplish successfully, which help in conveying concepts of weight and exchange of forces (Lowery np). Many critics focus mainly on the motion capture system's ability to record subtlety of performance, which is its main purpose. Already this presents us with a number of advantages and disadvantages of the technology. Motion capture not only records subtle facial movements, which in itself is a difficult task in traditional CGI, but also subtle hand movements. Furniss cites Shane Cooper, who argues, "people are very critical of facial animation,' in terms of sensing the 'realism' of a character" (Furniss np).

Here, once again, our attention is drawn to the importance of creating facial performances that are "realistic" or believable to an audience. The face is the most important tool in which a viewer can gather information about who the character is and what emotions they are conveying. When presented with a character, human or anthropomorphic, a viewer is able to get a sense of what the character is feeling through body language, but more importantly, the viewer is naturally drawn to look at the face in order to read thought processes and emotions. It is because of this that animators have spent so much time studying the movement of the face in order to communicate emotional performances and also to present a character that the audience will believe to be a real person and someone that they can relate to.

2.4. Realism in Motion Capture

Motion capture made it possible for this to be achieved faster and more

accurately because in key-framed animation, the animator has to consciously animate movement that usually will come subconsciously to a performer. When watching the human face, the viewer will pick up essential information from its movement to make a judgement on what the human is communicating. But it is impossible to mentally pick up all movement and information conveyed in a face all at once, which is why animation of the face has proved to be significantly difficult. Research done by Wages, Grünvogel and Grützmacher on realism and aesthetics in computer graphics state:

The attempt to 'simply copy nature' neglects the fact that the information contained in different stimuli for human senses divides into *essential* and *non-essential* information. It is safe to say that the vast majority - definitely more than 90 percent, maybe even more than 99 percent - of this information is non-essential insofar that it is filtered out physiologically and mentally. Hence it will not be used at all by our senses and mind to create an inner image of the 'real world' (3)

This not only describes the human inability to analyse a realistic facial movement accurately, but also how this information is filtered in our brains to a point where we mentally discard what we see as useless information. This is the reason why motion capture has proven to be both useful as well as ineffective. Motion capture possesses the ability to record the subtleties that humans have not picked up subconsciously and therefore can produce realistic performances of the face and correctly activate the muscles of the face that convey certain emotions. However, imitating reality along with all the detail it encompasses also causes complications. According to Wages' research, "Humans undoubtedly are optimized for the perception of certain details (e.g. faces, movement)" (4). They describe that the more realistic an

animation is made, the more aware we become of inconsistencies in the performance as we compare it to reality and therefore judge these facial movements as spastic. Like Masahiro Mori, Wages et al. believe that the increase of realism can ultimately lead to the decrease in believability (4).

Despite motion capture's ability to imitate reality, it seems it has required animation aid in order to provide quality animated characters. Subtlety is not always achieved successfully in the first shooting. What renders out on the computer screen is a map of floating dots representing the areas of the face or hands. These dots still need to be interpreted. Ellen Besen interviews Charlie Bonifacio, a former Disney animator, who argues that the computer cannot interpret the dotted data on its own without the help of the animator, who applies the animation to the data in order for it to mimic a moving character who creates meaning: "So, just as Disney animators only use rotoscope as a first draft of the animation, "mocap" works best when the captured material is interpreted by an animator with a trained eye who can reconnect those arbitrary points to emotional and physical meaning" (Besen, 2005). In addition, Furniss argues the same point, stating that only the high quality motion capture projects require post production work on hand and facial performance, "creating nuances that make characters more complex", and noting that in lower budget motion capture projects, close ups on these subtleties are avoided (Furniss; np). Besen quotes Bonifacio:

In the classical process, there's a level of subtlety that is not only hard to control with a pencil but also get through all the production stages without being lost. That shift in degree of subtlety is noticeable to lots of people who have moved

from classical to CG.... Of course, how much subtlety the technology allows is only one half of the equation. The other factor is whether people have the skill to access it (Besen; 2005)

The level of realism and subtlety, however, does not necessarily indicate how believable a character will be in an animated film. Where motion capture is needed to mimic reality for special effects shots catered for live action films, it is not necessary for a film that is fully animated. Animation, the illusion of life, has proven to produce abstract worlds and characters that are just as, if not more, appealing than characters that are created more realistically. It is important to note that in this instance, viewers will readily believe an animated character based within an animated world and therefore will not expect the animated character to move exactly like a naturalistic character. Both Deborah Reber, who interviews the Executive Producer of the Digital Animation Group at Nickelodeon, as well as Furniss, note that there is a substantial difference from the way humans move in reality compared to the movement of an animated character. Motion capture records movements at an even pace, which mimics natural human movement but differs in the exaggerated acceleration and deceleration movements of the animated character. It is due to this fact that motion capture is not suitable for cartoon performances (Furniss np; Reber 1999).

2.5. Motion Capture vs. Traditional Key-Framed Animation

What made more traditional versions of animation appealing to viewers, including CG key-framed animation, was the way that the character could perform which live action cannot mimic. Principles were applied to the animation, which

included anticipation and reaction, exaggeration and squash and stretch, and the characters did not necessarily have to adhere to the physical laws of the real world in order to be more believable. A human performer in motion capture cannot mimic these qualities of animation, without special editing afterward. In fact, nearly all animated or 'cartoon-like' characters are much more difficult to create using the motion capture system.

According to Alberto Menache, the author of *"Understanding Motion Capture for Computer Animation and Video Games"*, there are a minimal number of traditional animation principles that can be applied to motion capture. First, 'animation principles' should be defined. Menache lists the animation principles as outlined by Frank Thomas and Ollie Johnston of Disney Studios. I will merely name and define four of these principles that are lacking within motion capture. Firstly the principle '*squash and stretch*' is a technique used in which the character's body may change shape, elongating and distorting in ways to emphasize performance and personality. The technique is mostly found in cartoons, but can also be found in the 3D animation in film today, although much more subtle. The human body cannot mimic this movement and performance, as it is bound to the laws of physics (Menache 66). Secondly, *Anticipation and Reaction* can be found in natural movement, but is exaggerated in cartoons, sometimes beyond physical boundaries. The *anticipation* technique is an indication of an action that is about to happen, such as bending the knees before a jump. The *reaction* or *follow through* is the result of that action. This may make certain actions more realistic in performance of a character, but animation tends to use the technique in such a way that humans can't mimic it. Again, however, this technique is mostly used in cartoon-styled animations and may not apply to the latest 3D films that have come

out in the exaggerated sense as it is referred to here. Lastly, and important in the distinction between motion capture and traditional animation, is the principle of *exaggeration*. This is a technique in which the characters movement or facial expressions are pushed past all physical boundaries to emphasize or dramatize the performance. This is used even in the 3D animation films seen today, even if kept to a minimum (especially when comparing it to cartoons). Obviously a human performance cannot achieve this. The captured data would need to be enhanced later on in postproduction in order for this principle to be attained. For as long as animation has existed, these principles have been applied to most commercial animation films. Audiences have become used to seeing animated characters perform in a certain way. Menache seems to agree, going on to argue that the eye has been attuned to a certain style of performance when referring to animation, admitting when first applying human motion capture to a cartoon character “the motion might look strange and even disturbing” and continuing to state that he “wasn’t used to seeing that kind of motion associated with a make-believe character” (62).

Menache argues that “as a rule of thumb, you should not use motion capture to animate characters that should have cartoon-style motion” (1999; 64). The design of the cartoon character, with proportions that are usually different to that of the human body, creates artefacts. This tends to cause problems such as large hands intercepting the body in a strange way when brought too close to it. This inevitably creates more work for the crew after the performance is captured, and in changing or tweaking the body during the performance, the essence of the performance may be lost. This also applies to instances in which a human has to perform in place of an animal. Humans inevitably lack the small nuances of animal movement and therefore cannot give a

convincing performance of the animal unless studied closely for a long period of time.

Menache argues:

The problem with animal performance is the same as with human performance: The talent has to be able to perform in a convincing way. If a particular motion is not feasible for an animal to do, then you cannot capture it. You can do small enhancements after the fact, like increasing the distance of a jump, but not much more. Animals cannot perform a part other than their own, and humans cannot perform convincing animal motion in most cases. (Page 64)

Furthermore, Lowery argues, it becomes easier to reshoot scenes that do not work rather than manipulate the existing data. This is because very few systems allow for real time viewing of the performance and some results may be unsatisfactory. Advantages, however, include the director's artistic license over camera angles and being able to choose the angle that best serves the performance. Costumes and makeup, body and age, lighting, colour and filters can be changed to whatever suits the narrative without limitations of set and casting (Lowery np). Additionally, one actor can perform the role of many characters, but this, according to some critics, limits the quality of performance, due to the actors or actor not being able to act off another character. Even Menache argues that "a typical problem with captured motion data is in the unmatched interactions between characters and props or other characters" (59).

2.6. The Necessity for Realism in Animation

Motion capture has come under much criticism from the animation community. It has proven to be both valuable to the advancement of animation performance as well

as a threat to traditional key-framed conventions. For the most part, the use of motion capture has been questioned because of its ability to mimic realistic performance. To what purpose is motion capture used in animation for a realistic effect where the story could have been told just as effectively using live action? These concerns are reflected by authors such as Michael Barrier, a critic of the *Monster House* (Gil Kenan 2006) film, who argues, “There was no reason for this film to have been made with motion-capture technology at all, except as a marketing gimmick... there’s a nagging sense that the animation, if it can be called that, simply isn’t necessary” (2006), and Stephan Rowley, another critic, who questions, “...what is the point of an art form that aspires, through the application of highly advanced computer technology, to successfully duplicate the impact of the century-old technology of live-action film? If completely realistic humans are the aim, then Zemeckis [director of *Polar Express* 2004] might as well have shot his actors conventionally” (2007).

Rowley furthers the subject, arguing that even Disney realized that by upholding ‘literal realism’, the characters’ performance became ‘stiff and inexpressive’. Art in animation lies in the fact that characters exaggerate their movements, which is not successful when rotoscoped or motion captured. He states in relation to *Beowulf*, another film relying heavily on the realistic quality of motion capture:

“There is none of the comic or dramatic exaggeration that a traditional animator would add. This is why the humans in *Beowulf* often seem so lifeless and off-putting, compared to the less realistic but truly animated characters in films that spurn motion capture such as *The Incredibles* (2004) or *Ratatouille* (2007) [Brad Bird]

Rowley concludes that there seems to be a difference between what is delivered by a fully motion captured film and a traditional animation. He claims that animation is defined as an art form in which, frame by frame, characters and narrative are brought to life. In his films, Robert Zemeckis separates the art form of animation with the medium of animation. His films exhibit the same look and imagery associated with the animation genre, but are also devoid of the artistry that defines what the act of animation actually is (2007).

2.7. Fully Animated Film vs. Special Effects Animation

One has to consider the reasons for motion capture's use in animated films before a critical opinion can be formed. It can be argued that the use of motion capture is merely use of referencing, helping the animators study the movement and performance of a certain character and referring to the motion capture data only as a base in which to work off rather than as the final performance. Furniss acknowledges this fact, as she references Richard Cray of the Performance Animation Society, noting that even traditional animators film themselves acting out the scene before studying the movement and applying it to their animated performance. The difference, she argues, is that this rehearsal is recorded in digital format and free for the animators to "use and reference as they see fit" (np).

In cases where motion capture is used for special effects in live action film, the reasons differ, favouring a more practical approach to its uses. David Bennett, head of the facial animation department at Weta Digital Studios, provides a more pragmatic

approach to its functions: Firstly, he confirms that directors are looking for a more realistic character to fit in with the live action scenario, which is provided more successfully by motion capture than by key-framed animation. Secondly, directors of special effect based films prefer the use of motion capture because of its allowance for the direction of actors instead of the reliance on an animator's revisualisation of the performance. It becomes safer to use realistic animation in place of a stuntman. Lastly, the actors can be transformed into any bipedal character needed for the film without having to rely on the limitations of realistic costume design.

It seems that there are two main reasons for the use of motion capture: the importance of reference in animation, as well as the ability to recreate a realistic performance. It appears that in key-framed animation, motion capture is unnecessary and does not make the characters more appealing. Motion capture is not successful as a replacement for what has become known as key-framed animation, however, in the case where motion capture is used in live action special effects, it seems more practical to pursue realism in order to convince an audience of its existence within our real world. Despite special effects heavy reliance on motion capture, the data provided by the technology still needs to be interpreted by an animator with knowledge in the art of key-framed animation. The data is tweaked by hand until a satisfactory result is acquired. Therefore, it can be assumed that motion capture has proven essential to the creation of realistic animated movement, but it is not sufficient on its own without the eye of an animator.

Chapter 3: Realism In Animation

3.1. Reasons for the Use of Realism in Animation

“The straightforward reason [for creating higher degrees of realism] is the strong and seemingly natural belief within the industry and among many artists that the resulting productions will consequently be more believable and immersive for the user”
(Wages et al. 1)

Scholars and professional animators have contended over the issue of the pursuit of realism in animation since the creation of the art form itself. Some argue that animation should remain an abstract art form, maintaining the ability to do what live action cannot do, while others believe that the pursuit of realism is necessary in order to create a connection between the viewer and the animated character. Professional animators such as David Bennett (Weta Digital Studios) and Gray Hodgkinson (a Programme Leader for the Institute of Communication design in New Zealand) have recognised the demand for realism in animation increasing exponentially in recent years. David Bennett states:

“I believe that in the near future, people will demand more 3D effects from their entertainment. People will want highly realistic and interactive virtual humans to interact with. Not only in film but in everyday life as well.”

While David Bennett works mainly in special effects for live action film, and as I've stated previously, it may be necessary for live action film to demand realism in animation in order for the animation to fit into the real world believably; Hodgkinson has made the same observation regarding key-framed animation, stating that an illusion of reality has to be conveyed in order to achieve the illusion of life (1).

It has been established since the first animated feature film that a certain degree of realism or verisimilitude is required within main characters in order to hold the audience's attention for the entire length of the film's story. However, many have questioned the necessity of the high level of realism being pursued in recent modern animations. Hodgkinson believes that in some cases, realism may make some forms of animations more successful as a “visually convincing and immersive medium”, whereas in other cases, it may cause issues (1).

3.2. Defining Realism

The term *realism* in all its forms proves to be a loaded and complicated concept being open to subjective interpretations. When referring to realism in broad terms, it becomes difficult to define as it is relative to how one person may perceive ‘reality’ to

the next. In this thesis, I will be referring to realism in animation and how realism is perceived in film, which is relative to what frame of mind we place on the *type* of film.

Wages also holds this same view:

"The notion of reality often refers to the 'world itself' containing everything, the nature as well as the culture. But when talking of computer games, the term 'realism' is often interpreted in a comparable or a partial sense. The notion of realism is used here to relate to reference point. For example: If the reference point is a fantasy world equipped with trolls, dragons and magic, the appearance of a tax man from a fiscal authority like in our real world would be regarded as extremely unlikely and unrealistic. On the other hand if we speak of realistic graphics the point of reference will be the sense-impressions we receive with our eyes from the real world and the graphics on the screen will be compared with those." (2)

Although Wages is referring to computer gaming, this view can also be held for computer-generated animation. Here, the term realism is relative to the 'frame' we place the narrative in. Animations are often placed in a world that is different to the real world, such as fantasy or science fiction genres, therefore, characters and worlds are considered realistic based on what can be considered 'realistic' for the world that the characters live in. Realism is a concept that is relative to a chosen point of reference. Therefore, like Wages, in this paper the point of reference for realism is in the computer graphics and character movement itself, comparing what we pick up visually from the real world to what we see in animation in cinema. For Paul Wells, the point of reference is the '*hyper-realism*' found in Disney animated feature films. Disney films have become a main reference for the concept of realism in animated films due to

the high levels of *verisimilitude* that Walt Disney had demanded in his characters and world of the narrative. Despite the ability for animation to do what live-action cannot do, Disney preferred his characters to move like real figures and therefore strived for greater realistic impressions. Wells argues that Disney “places the issue of ‘realism’ at the centre of any discussion of animation” for this very reason (24). As I have stated previously, however, Paul Wells, Ollie Johnston and Frank Thomas all agree that Disney rightly assumed that the inclusion of realism or verisimilitude was necessary in animated film to sustain the audience’s attention for a significant length of time. Therefore, an *exaggerated* reality, or *caricature* of reality is conveyed through animation and it is this representation of reality that I will be referring to in the rest of the discussion. Wells defines the key codes of *hyper-realism* through four requirements: 1) design, context and action can be associated with live action film; 2) all objects and characters are subject to the natural physical laws of the ‘real’ world; 3) sound corresponds diegetically to the action, as would happen in the ‘real’ world; 4) the bodies of the characters will be subject to the same physical limits as humans and creatures of the ‘real’ world. The more these conditions are met, the higher the degree of verisimilitude (25-26). The concept of realism in animation in this paper will be defined using the same requirements listed above.

3.3. The Appeal of Realism

It is important to note at this point that the necessity for realism in animation varies depending on the reasons for its use. In traditional animation, it has proven to be unnecessary and in many cases, not as appealing compared to the abstract or stylistic freedom taken with the design of the characters and the world. Although traditional

and computer key-framed animated feature films have been more successful using characters and contexts that aspire to verisimilitude, there have also been films created using completely stylised characters placed into a flat and stylised world, which have been successful in a feature-length film. Examples of this include *South Park: Bigger, Longer and Uncut* (Trey Parker 1999), an animated series as well as feature-length film conveying characters made up of geometric shapes and flat colours; and *Simpsons: The Movie* (David Silverman 2007), based on the TV series about a yellow cartoon family who perform in an exaggerated manner and are styled with black outlines and flat colours. When asked if realism makes a character more successful or appealing than an abstract character, David Bennett answered, “Personally, I love the TV show South Park and it is about the worst animation on the market. Therefore, I don't think realism is necessary to create characters that people love to watch. I think the Uncanny Valley is correct in the sense that it's only when we get close to realism that things get ugly.”

Experiments carried out by Wages et al. in their article “*How Realistic is Realism?*” have shown some interesting results regarding how humans and animals may react to stylised or exaggerated stimuli. Firstly, observations included humans reacting negatively to more naturalistic, yet not completely realistic computer generated characters, which echoed the findings of Masahiro Mori's *Uncanny Valley* theory. However, viewers seemingly responded more emphatically towards anthropomorphism found in robots or characters, but only to a certain degree. In tests done on certain animals, Wages found that by exaggerating the stimuli presented to the animal rather than mimicking the stimuli realistically, the animals responded in an exaggerated manner, a seemingly more successful reaction. Wages describes this as working “better than the original although they are far from being realistic” (4).

What is implied by these studies is that realism in animation does not necessarily mean that the animation will be more successful, nor more appealing. Additionally, it seems that identification by the viewer to the abstract character is not problematic either. The medium of animation and its ability to go where live-action cannot go is what allows the acceptance of the abstract, non-realistic character. Paul Wells argues:

“Animation does not share the same method and approach of the live-action film. Rather, it prioritises its capacity to *resist* 'realism' as a mode of representation and uses its various techniques to create numerous styles that are fundamentally *about* 'realism' (25)

3.4. Identification to Realism

Wells indicates how animation can represent reality without actually being realistic in itself. This would describe the reason why we as an audience, will accept more abstract or stylistic characters as 'real people' without them having to look like or move exactly like a real person. However, I am inclined to argue that despite the ability for non-realistic characters to be appealing, I agree that the characters must maintain some form of verisimilitude in order to believably carry the narrative. Perhaps it is not necessary for the animation to be *realistic* as such, but rather carry notions of *verisimilitude*, which allows for relatable *representation* of reality, but at the same time allows the characters to perform exaggerated feats and performances that cannot be achieved in the real world and will in turn not be questioned by viewers. Former Disney Chief Jeffery Katzenberg describes the phenomenon as being “*Exaggerated*

Reality” while referencing a section of *Pocahontas* (Disney 1995), where Pocahontas, a character animated with verisimilitude, dives off an extremely high cliff into water without any harm. A film done in this way meant that the realism of the animation allowed for far-fetched actions to take place while still providing believability to the realist-rationale, while the ability of animation to challenge rationality could still be maintained (Wells 26).

Furthermore, the use of verisimilitude instead of pure reality allows anthropomorphic characters to be created and despite acting significantly human-like, the viewer will identify with the character making it more believable. This creates a powerful tool for the animator to communicate ideas solely through the design of the character e.g. a feline-like villain will connote a strong, powerful leader, usually on the hunt for an innocent victim. Animation is a subjective medium and therefore allows the freedom to design a character in a certain way to connote certain ideas. Wells quotes two British animators, John Halas and Joy Batchelor, “If it is the live-action film’s job to present physical reality, animated film is concerned with metaphysical reality – not how things look, but what they mean (11).

3.5. Realism for Special Effects

This argument shifts when referencing realism in special effects animation found in live-action film. Often, animation in live-action film serves the purpose of briefly replacing actors during stunts, or placing characters, creatures or elements that are not of our world, into our world. It is for this reason that animated elements added to the film need to appear realistic, fitting in with our world and all the physical laws and

mechanics it may be governed by. Without this element of realism, the animation may appear out of place, jolting a viewer out of their suspension of disbelief. It is necessary for the animated characters and objects to appear as though they are made up of the same matter as the elements and beings of our world. It is in this case that the pursuit of realistic animation may prove to be necessary. Even in this instance, fully animated humans are avoided and animation is mostly used for non-human characters and stunts alone. Hodgkinson argues:

“Indeed this is successful in visual effects and stunts, where the computer generated stand-in replaces the actor temporarily. This substitution is usually very successful and unnoticed by the audience. However, in such cases, the CG stand-in is usually used in stunt scenes, or far from the camera, where detail and readability is diminished, blurred, or obscured by fast cuts. The audience simply does not get the time to experience disjunction between the image they see and their memory of what it “should” look like. In this area of visual effects, realism is working, and getting better every day.” (1)

It is important to note at this point that animations of human characters in live-action films are mainly used for stunts alone, where a director can place an actor in a dangerous event without having to put the actor in any physical danger. But as Hodgkinson states above, these figures are usually placed in fast-paced, short shots where its visibility is blurred or obscured in some way. (repeat) The danger of approaching realism in animation is based on the fact that viewers respond negatively to realistically animated humans, because the animated humans do not move exactly like a real human. Humans subconsciously memorise how real people are supposed to

move and perform and therefore, if an animated character appears realistic, it also has to move realistically in order to avoid the Uncanny Valley (Hodgkinson 2). It is for this reason that animated humans are avoided in live-action film, especially when the character is displayed against a real human in the same film, it becomes impossible to believe that the character is real.

3.6. The Realistic CG Human

Despite the dangers, a recent hybrid of films have evolved which allow for the mixture of animation with live-action, so much so that animation seems to be the dominant medium in certain films such as the more recent *Alice in Wonderland* (Tim Burton 2010), in which Alice finds herself in a land made from the imagination, complete with fantasy characters; as well as *Avatar* (James Cameron 2009), where an entire planet and culture of aliens had to be animated. I would argue, however, that the reason behind films such as these being successful, is because fully animated *humans* were avoided. David Bennett agrees that the human eye is attuned to the subtleties of another human's movement, but by changing the character to that of another species, means that we do not judge them in the same way that animated humans are judged.

Facial animation, however, has been difficult to achieve successfully in both virtual humans as well as virtual creatures. Even though the problem of realism may be avoided when dealing with non-human characters, these characters are usually anthropomorphic in some way, which implies that their facial movements relate in some way to human facial movement. Even anthropomorphic animal faces are constructed in such a way that they might express their emotions through a

combination of facial positions, such as the eyes, brows, nose and mouth, in the same way that a human may express emotion through their face. Here a viewer may expect some degree of realism, or at least verisimilitude, which is why the introduction of technology that is able to record such subtle data has proved successful.

Chapter 4: The Uncanny Valley in Animation

Thus far, it has been established that notions of realism have been sought in the creation of feature-length, animated films. To a certain degree, it has been necessary to pursue a level of verisimilitude that allows for the audience to identify with the character and immerse themselves fully into the narrative. However, in recent films, higher levels of realism have been practiced, which in some cases, like special effects for live-action, were successful, while in other cases they failed in terms of believability. Most of these cases included fully animated films that pursued realism to fit the conventions of live-action film. Examples of this can be found in films such as recent Zemeckis productions: *The Polar Express* (Zemeckis 2004), *Beowulf* (Zemeckis 2007), and *A Christmas Carol* (Zemeckis 2009), where all cast members were motion captured to look like the actors themselves. When animating a character based on real people, the viewer expects a level of realism in order to identify with that character. Caridakis et al. argue that the ability for a virtual character to emote expressively is an important aspect, to appear more natural to the viewer (368).

However, the criteria between fully animated film and animation as special effects in live-action film differ significantly. Hodgkinson argues that in the case of full animations the realistic elements are presented to the viewers constantly, where the viewers are asked to suspend disbelief and become fully immersed in the animated

world. The problem with this, however, is that the constant exposure to the imitation of realism means that the viewers have time to judge the performances presented to them as a real person's performance, and this introduces the phenomenon known as the *Uncanny Valley* (1).

4.1. The Uncanny Valley

Hodgkinson describes the Uncanny Valley, a theory written by roboticist Masahiro Mori, as the “eerie feeling a viewer can experience when encountering almost-human robots” (Hodgkinson 2). Mori describes our feelings towards prosthetic hands as an example to describe how the uncanny feeling is developed:

“Some prosthetic hands attempt to simulate veins, muscles, tendons, finger nails, and finger prints, and their color resembles human pigmentation. So maybe the prosthetic arm has achieved a degree of human verisimilitude on par with false teeth. But this kind of prosthetic hand is too real and when we notice it is prosthetic, we have a sense of strangeness. So if we shake the hand, we are surprised by the lack of soft tissue and cold temperature. In this case, there is no longer a sense of familiarity. It is uncanny. In mathematical terms, strangeness can be represented by negative familiarity, so the prosthetic hand is at the bottom of the valley. So in this case, the appearance is quite human like, but the familiarity is negative. This is the uncanny valley” (33)

The theory referred to robots that had been created to resemble humans, stating that

the more human-like the robot appeared, the less appealing it became to its spectators. The reason for this was because as a robot approached more realistic human-like characteristics aesthetically, the more the viewer expected the robot to move and act like a real human. Of course at this point in time, this concept is impossible to achieve. We do not have the technology to create robots that are indistinguishable from humans and therefore an eerie emotion develops in the presence of these human-like robots.

Mori presented a graph to describe this phenomenon:

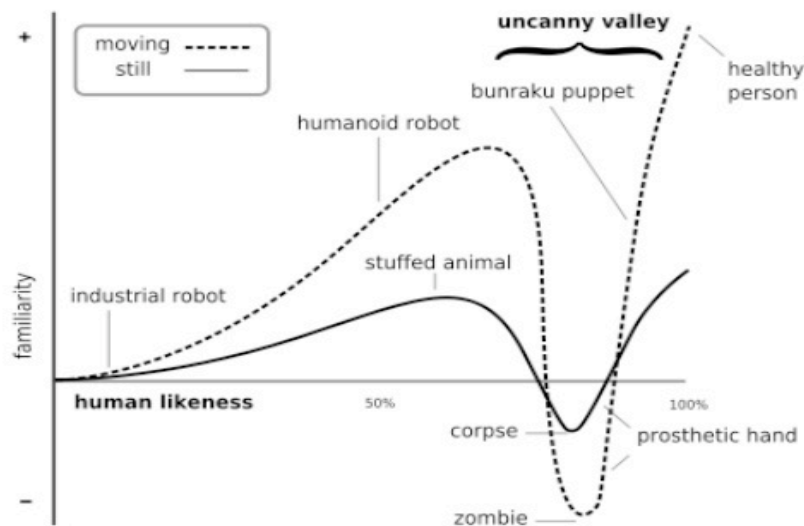


Figure 1: Mori, Masahiro 1970. The Uncanny Valley.

In this graph, human-likeness is mapped out against our familiarity (or appeal) to that entity. Mori illustrates how we share little familiarity with robots that have little or no human-likeness and therefore we treat them as something mechanical and lifeless. As the human-likeness of these artificial beings increases, so does our familiarity with them, and the viewer will find them appealing. This can be seen in

notions of anthropomorphism (like stuffed animals), or robots with certain human characteristics. However, as the artificial being reaches higher levels of human-likeness, to the degree where the artificial being resembles a realistic human but does not move like one, there is a significant drop in their appeal, making them almost repulsive to the spectator. It is this dip in the graph that is termed *the Uncanny Valley*. It is only once the artificial being can mimic another human in all areas of representation *accurately*, that the spectator will again begin to familiarise with the artificial being and accept it as appealing (33).

4.2. Mimesis vs. Abstraction

Although this theory was originally written with regards to robotics, the concept can still be held true for other artificial beings, or more specifically to this discussion, virtual beings. Relating to the previous discussions on the appeal of abstract/more stylistic characters in comparison to more realistic characters, we can place some of the types of characters that have been discussed, onto the graph. We will replace the robot artificial beings with levels of characters ranging from the completely abstract to the completely realistic.

Maureen Furniss, animation scholar and author of *Art in Motion: Animation Aesthetics*, suggests that an effective way in which to view animation would be in relation to live-action film (5). Using this relation, Furniss created a graph in which to represent the animation/live-action relationship, where one side of the graph would represent films that reach *mimesis* (the imitation of nature and human behaviour in art and literature), and the other side *abstraction* (a suggestion of a concept rather than a

representation of it in real life terms)(5). She presented a graph to illustrate this idea, which I will interpret in a more general sense:

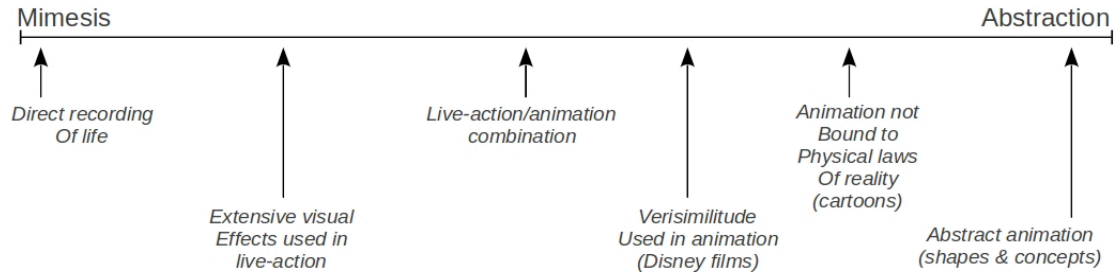


Figure 2: Own representation of Maureen Furniss'

Mimesis/Abstraction graph. Original: 1998.

Here, Furniss describes how the relationship between mimesis and abstraction is relative, and rather than being categorised as separate concepts, should be represented as part of the same motion picture frame (6). The labels given to certain kinds of film in the graph above are not fixed, only an indication of the development from abstraction into mimesis. Their placement is relative and may change depending on the viewers of these films. Nevertheless, I propose to create a graph in which Furniss' graph as well as Mori's graph are combined in order to create a representation of where animation stands within the Uncanny Valley theory, using the same abstract to mimesis evolution:

4.3. Animation and the Uncanny Valley

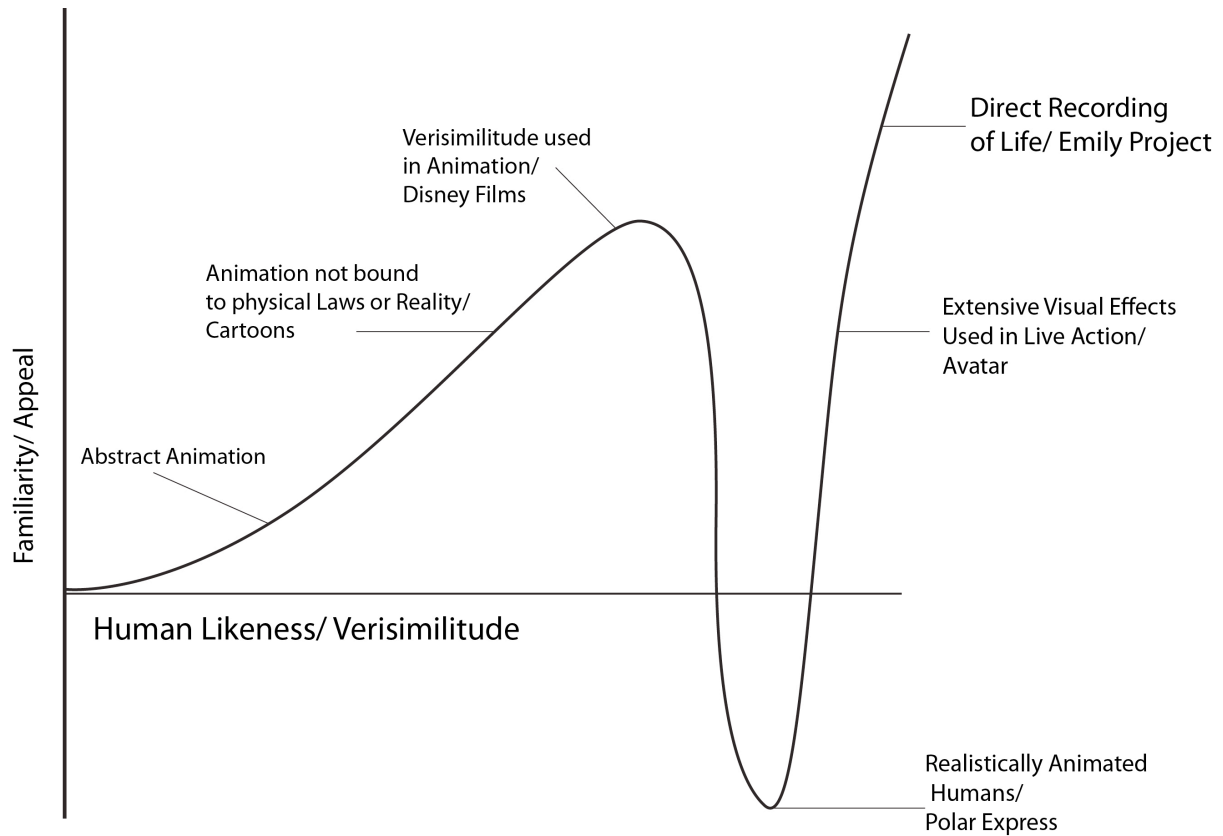


Figure 3: Personal Interpretation of the Uncanny Valley as it relates to animation

In terms of human-likeness, the one side of the graph would represent characters that are completely abstract. They contain little to no human-likeness and therefore we do not familiarise with the characters as beings with a complex personality, but rather look to them for the representation of a mood or idea. Towards the middle of the graph, there are characters that contain anthropomorphism, usually animals or other beings that portray certain human traits and personalities. I would argue that stylised human characters could also be included in this area, as the

characters are simple representations of the human form rather than an atomically correct portrayal of the human body. Also, the performances are exaggerated in certain ways in comparison to natural movement and performance of real humans. I would argue that next on the graph would be the more recent portrayals of believable characters in animated feature films. Here, a higher level of verisimilitude is added to the characters, and their mechanics, as well as performance, relate more closely to that of the real actor. Included in this example would be lead characters typical of Disney films and characters created in CG key-framed animation. Characters like these tend to possess an appeal that holds the audience's attention for the entire feature film.

As the characters reach more realistic levels, such as those characters who relied heavily on motion capture systems to capture performance and characters designed to look almost-human, they begin to fall into the valley of the graph. Examples of these types of animations include *The Polar Express* and *Beowulf*, where as I have mentioned before, the characters were based entirely on the appearance and performance of the live-actor. The reason for this is that the motion capture technology used to create these characters was successful in recording more accurate timing and subtle performances, but the technology was not advanced enough to make the animated characters indistinguishable from real humans. With characters that looked almost-human but differed slightly in movement to a real human, lost their appeal to the audience and the characters fell into the Uncanny Valley.

Despite the dangers, the significant effort to achieve a high level of realism still persists. Professional animators and animation companies are well aware of the theory of the Uncanny Valley and how it relates to animation itself. Therefore, the

decision is made either to pursue a more stylistic aesthetic, making the characters less realistic, or to attempt to create characters that might cross over the Uncanny Valley. Companies such as Image Metrics, who have come up with a system to scan in realistic facial expressions from a human actor to control the facial animation of a film character, and Weta Digital Studios, who are developing motion capture technology to portray more realistic performances than previous motion capture technology, are examples of such companies who pursue the latter option. When asked why the experimentation of realistic characters still persists in films such as *The Polar Express*, even though these characters became examples of the Uncanny Valley, David Bennett (who also worked on motion capture for *The Polar Express*) answered, “The Polar Express was the first time Facial Mocap was ever used on a film. There were issues that needed to be worked out in the technology. Most movies these days are getting close to cracking the issues associated with the Uncanny Valley.”

4.4. Causes for Unease

Many reasons can be speculated for the feeling of unease one will attain when viewing realistically animated humans. Firstly, during the experiments done by Wages et al., they established that the human senses can only detect a certain amount of information from a stimulus, dividing the information received into “*essential* and *non-essential* information”. Wages argues further that most of the information received from the stimulus will be categorised as non-essential information, as it is filtered out mentally and therefore our perception of reality is only made up of the *essential* information that is left over (3). In many ways, this is where key-framed animation has proved to be successful. Animators are trained to communicate a character’s

performance by exaggeration of certain actions and movements, using each action to describe the motivations and emotions of the character. Here, the actions become more isolated and clear to the viewer, and the viewer has become accustomed to seeing animation in this way. In the same way, the viewer has become accustomed to viewing live-action performances in a certain fashion and therefore, when animation is made to imitate the live-action style, the viewer places the animation in a live-action frame and expectations are formed around how the animated character should perform. It seems that there can be no mid-ground reached between these two extremes. When a viewer is presented with an animated character, to satisfy their expectations, the animated character must either move in a traditional animated manner or must move exactly like a real human. Most animations fall short of reaching performances that are indistinguishable from a real human and therefore fall into the dangers of the Uncanny Valley. Christoph Bartneck et al., authors of *"Is the Uncanny Valley an Uncanny Cliff?"*, further describe action of placing a "frame" on another being depending on the viewer's expectations:

"When we encounter a very machine-like robot, we select a 'machine frame' and its human-like features deviate from our expectation and hence attract our attention. This deviation is usually positive since we tend to like other humans. In contrast, when we encounter an android, we select our 'human frame' and its machine-like features grab our attention." (2)

Like the Uncanny Valley, the statement made by Bartneck can also be applied to animation. Viewing realistically modelled humans, means that we will expect the character to act exactly like we do and any slight discrepancies between the CG

character and a human will be immediately brought to our attention. Mori includes the same argument in his Uncanny Valley theory, providing an example of the act of laughing, in the human face, where even the aspect of the speed of execution of the facial expression can affect how human-like a virtual character may appear. A laugh at half the speed of a normal laugh appears unnatural and slight details such as these cause the fall of these characters into the Uncanny Valley (34).

4.5. CG Human Characters and the Uncanny Valley

Thus far, it has been established that there is an increase in the desire for realism in animation. However, this becomes problematic when pursuing realism in human characters, as they are more susceptible to the dangers of the Uncanny Valley. In the examples discussed, it was also established that until now, technology had not been developed enough to make realistic human characters capable of reaching the other side of the Uncanny Valley. It appears that due to the viewer's ability to memorise human motion, virtual characters receive a significant amount of pressure to appear identical to real humans. Hodgkinson terms this phenomenon "infinite acceptance': as animation realism increases, so does the viewer's criteria for acceptance" (2). This implies that only virtual characters perfected to the stage where the viewer is not able to pick up slight variances in its performances will be accepted.

4.6. Stylisation in Animation

This further implies that more stylised characters that are bound to the conventions of animation may prove to be more appealing to an audience at this

present time. Not only do these characters completely avoid any risks of the Uncanny Valley, but according to research done by Mori, Bartneck and Wages et al., it seems that humans respond more positively to these stylised characters. Wages found that humans “responded more emphatically” towards characters that bore more anthropomorphic traits, while tests done by Bartneck showed that anthropomorphic robots, toys and humanoids were preferred over real humans (Wages 4; Bartneck 10). The most interesting finding of Bartneck’s research is that the viewers preferred the anthropomorphic characters over *real humans* and not only *realistically created artificial humans*. A real human is not an entity that falls into the Uncanny Valley, in fact, in theory it is the very concept that reaches the other side of the Uncanny Valley, however, it seems that viewers will find anthropomorphic characters more appealing than even the average human. Bartneck and Wages have both argued that stylisation and anthropomorphism are both more acceptable as well as appealing to a viewer than artificial realism, with Wages concluding that a stylised stimulus can have a more exaggerated effect on the viewer than the genuine stimulus (7). The CG animation film company Pixar’s earlier success can also be accounted for in this way, as their films focussed on non-human characters, such as the toys in *Toy Story* (John Lasseter 1995), the fish in *Finding Nemo* (Andrew Stanton 2003), and the monsters in *Monsters Inc.* (Pet Docter 2001), while more digitally realistic pieces failed to attract the same amount of attention (Bartneck 2). Only when technology had evolved significantly did Pixar animate humans as main characters in *The Incredibles* (Brad Bird 2004), and even in this situation, the humans were highly stylised and cartoon-like.

4.7. The Demand for Realism

Despite many indications that stylised characters have proven to be highly endearing and appealing to a viewer, the discussion so far has shown that we familiarise ourselves with human characters, especially human characters with more verisimilitude. As a long-standing animation convention, stylised characters have not always proven sufficient for a lead role in an animated feature film. Hodgkinson argues:

“...a convention that states that the lead roles should in fact be the most realistic... The deliberate generic realism is intended to increase identification by the audience, in that the character is a “bank sheet” upon which the viewer can place themselves. It is thought that stylisation may reduce audience identification, in that not everyone will agree with the style... To bring out a character's personality through stylisation is a well established skill that not only endears an audience but gives extra expressive depth to any performance.” (2)

It seems that there is a tension between manual transcription and artistic interpretation in this case. What Hodgkinson is arguing in the above statement is that convention dictates that verisimilitude is needed in lead animation roles in order to help audiences identify to the character, however, stylisation of the character's design and performance can bring out exaggerated responses as well as “expressive depth”. It seems these observations further emphasise how realism is necessary depending on the type of film that is made. In fully animated feature films, it is possible that these more stylistic characters are better suited for the appeal of the film, whereas in a live-

action film containing special effects, animation will require the characters to look completely realistic.

4.8. Loopholes in the Uncanny Valley

One has to consider, also, that it is possible to view highly realistic virtual characters in certain cases without experiencing the feeling of unease, which will in turn account for the high demand for realistic animation recently. Hodgkinson notes an important loop hole within the Uncanny Valley, arguing that although Mori's graph suggests that the virtual human has to imitate a real human almost perfectly before the feeling of unease will stop, his theory does not take into consideration the awareness of the viewer as a factor (2). This implies that the viewer will always feel a sense of unease with the knowledge that what they are encountering is not human, which in turn also implies that if the viewer is not aware that the being is artificial, they will not find it strange. Although this is a valid and feasible argument, it would only be truly viable in the presence of a highly realistic almost-human character. In many cases, one can easily discern between real life and realistic CGI animation and, therefore, will always have the knowledge that what they are watching is not real life.

This is another point Hodgkinson brings to light. He argues that the viewer's knowledge that what they are witnessing is an imitation of reality and not actually an *experience* in reality, will mean that the viewer will suspend their disbelief of the events within that film for its entire length. This will mean that the viewer will accept what they see on screen and will not feel a sense of unease when presented with its characters (2).

Bartneck et al., however, view this argument in a different fashion. Bartneck executed tests in which pictures of robots, humans and toys were presented to the human participant. He labelled each picture as either *robot* or *human* and evaluated the participants' empathy towards the character in the picture. Although his findings included more anthropomorphic characters being rated higher in the scale of appeal than real humans or realistic robots, he also noted that the framing placed on the picture did not seem to have a significant influence on their reaction. Participants rated the picture independently from the label, focussing on its appearance for its likeability. He argues, "A highly human-like android is not uncanny because of the fact that it is a robot, but because of its appearance" (9).

These findings indicate that despite viewers being able to establish that a human character is virtual, it is not this knowledge that influences how the viewer will feel about the character. It seems, from the arguments presented above, that the demand for realism in animation is based on the ability to create appealing realistically modelled humans, which in turn describes why realistic virtual humans can also hold a significant amount of appeal over stylistically created humans. However, it seems that it is then the movement and performance of these characters that will give the sense of unease and draw the viewer's attention to its artificial traits.

4.9. Overcoming the Uncanny Valley

Despite the dangers involved, research continues into the development of

realistic virtual characters. Up until recently, technology had not developed adequately to produce the high levels of realism needed to cross the Uncanny Valley. Image Metrics, a leading facial animation company, developed a new high-resolution face scanning process using light stage systems in order to produce realistic facial animation. Using actress Emily O'Brien as a model, Image Metrics created successful methods in which to imitate her face digitally. Hundreds of images of the actress's face from every lighting direction were captured one at a time, allowing for very accurate facial reflectance to be recorded and simulated. Image Metrics planned out thirty-three facial expressions in which to capture Emily, based loosely on Paul Ekman's *Facial Animation Coding System*, and with it, successfully created a fully rigged, animatable face for the digital Emily. The results seemed to be the most successful attempt at crossing the Uncanny Valley to this date. Short videos made on the project portray Emily speaking to the camera about Image Metrics and the digital Emily Project, and only in the end is it revealed that the actress presenting the company is in fact, the digital version of Emily. This model, it seems, is astonishingly identical to the original Emily and does not seem to create the feeling of unease one gets when dealing with realistic virtual humans. This is because, until the end, the viewer is lead to believe that the Emily on screen is the original Emily. The process, however, took a significant amount of time to complete and requires expensive equipment in order to create the results presented. Therefore, economically, creating realistic animation using this process is not viable. But it is definitely an important and successful step towards creating virtual models that cross the Uncanny Valley.

With technology's ability to successfully create realistic animation, it seems that in future, the Uncanny Valley will be a problem of the past. This does not necessarily

mean that realistic animation is more appealing. I would still argue that realistic animation is required only in live-action special effects, with more stylised animation being better suited to fully animated narratives.

Chapter 5: Case Study

Gollum, Lord of the Rings Trilogy

5.1. Introduction to Lord of the Rings and Gollum

“Between the release of *The Matrix* in 1999 and its sequels in 2003, the public excitement surrounding computer FX had moved to fantasy with the release of Peter Jackson’s *The Lord of the Rings trilogy* (2001-2003). And it wasn’t the spectacle of the Mines of Moria or the vast Orc armies fighting in the Battle at Helm’s Deep that captured the most public and critical attention, but rather the sadly emaciated and shrivelled body of Gollum, the former ring-bearer.” (Abbott 96)

When the *Lord of the Rings* (Peter Jackson 2001) was released into cinema, the epic fantasy-adventure narrative contained a vast amount of CG effects that brought the world of the story to life and astounded viewers. However, the most noticeable and exciting achievement made by the film seemed to be Gollum, a CG character who possessed a personality and emotional performance like no other CG character had before. Fully computer generated characters had been seen previously in movies such as *The Terminator 2:Judgement Day* (Cameron 1991), *Godzilla* (Emmerich 1998) and *Jurassic Park* (Spielberg 1993). None of these characters seemed to evoke emotional performance like Gollum managed to in his performance. *The Lord of the Rings* was the first film to combine the live actor with a CG character so extensively. It is because of

this that Gollum became a milestone in CG character animation and performance in live action film.

5.2. The Use of Animation in Lord of the Rings

The narrative of the Lord of the Rings required elements of fantasy to appear *real* in the physical world. While the casted actors and environments in the film were used from real life, characters such as the Orcs, walking trees, the Black Riders and the most prominent, Gollum, were put under pressure to fit within the elements of the physical world. Creating CG that would look like it fits within this world meant being able to create computer imagery that appeared 'real' or mimicked the necessary proportions and textures of the original object. For the character or object to appear real, it must be adopted within the traditional cinematographic codes and conventions and maintain the illusion that it is shot with a 'real' camera by displaying properties such as motion blur, depth of focus and the grain of the film stock (Abbott 91). For a bipedal character that was previously human, such as Gollum, there were two approaches. Jackson could have either chosen a live actor to dress in costume and perform the part, or CGI technology could be used to create the character performance. Given the proportions and appearance of Gollum, it quickly became clear that no human is proportioned in the same way and therefore any possibilities of costumes were ruled out. Originally, Jackson planned Gollum to be a traditionally key-framed CG character, although it soon became apparent that in order to capture the subtlety needed for a realistic performance, he would have to rely on motion capture technology. Abbott, author of a journal article on science fiction and the use of CG characters in modern film, argues:

“The way this character is described in the novel – physically twisted, emaciated, wretched, walking on all fours, and crawling up and down cliff faces – made it impossible to achieve with a human actor, and yet the importance of the character meant that it needed to be more than a photo-realistic CG creation. It needed to give a genuine dramatic performance. As a result, the team developed the most sophisticated combination of CG animation, motion capture, rotoscoping, and actor performance yet to be achieved in cinema.” (103)

It was necessary to make Gollum blend in with the live actors, especially now that Gollum himself would not be real. The technology now gave one significant advantage over the use of costumed actors, which was the capacity for the character to be able to stretch its own physical limits. For a bipedal character like Gollum, the basic body mechanics needed to be apparent and believable, which was provided by Andy Serkis, the actor used for the motion capturing process. However, Gollum was a character who needed to be able to achieve physical feats which humans cannot accomplish, such as climbing down cliff-faces, jumping and stretching in ways that humans cannot. This became the most prominent reason in which to have an animated character in place of costume and make up.

5.3. Motion Capture in Lord of the Rings

Initially, Peter Jackson had intended Gollum to be a fully computer generated and key-frame animated character. Yet once it was discovered that the level

of reality necessary for the animation was significantly higher, it was decided that Gollum would be motion captured. When Andy Serkis was recruited to play the part of Gollum, he was intended only as a reference for animation performance. But it soon became evident to Peter Jackson that Serkis' performance would ultimately drive Gollum's character, as he had the ability to encompass the emotions and performance of Gollum to the point where the audience would believe in the character as an emotional being and therefore relate to him (*Taming of Sméagol*)

The use of motion capture also opened many additional opportunities for the Lord of the Rings team. For a director such as Peter Jackson, it is easier to be able to direct a live-action crew than it is to direct an animated character. Traditionally, animation had to be plotted carefully, planning each frame and routine to the last detail before a performance of the character could be made. Only once the animation had been completed for a shot several weeks later, could the director look at the footage and make important decisions for the shot, such as additional performance needed or the recreation of certain elements. Inevitably, the process becomes an expensive and time-consuming operation. What became beneficial for Jackson was the ability for motion capture to allow him to view both the performance of Andy Serkis as well as the roughly rendered version of Gollum's resulting performance in real-time (Jackson; *Taming of Sméagol*). This meant that Jackson had the opportunity to direct "Gollum" in the way that he would direct an actor and was allowed the freedom of re-shooting any scenes in which he desired a different performance.

This further signifies the advantage of costs in terms of purchasing reels of film. Motion capture allows the team to go back and change or add certain elements as

needed without the cost of wasting expensive film (Serkis; *Taming of Sméagol*)

The most important reason suggested by Peter Jackson for the use of motion capture was for the element of realism. Jackson acknowledges key-framed animation's ability to achieve realistic performances from characters, but points out the amount of time a process such as this would take:

“When you move elements such as the head, certain muscles of the neck are affected and so subtle that you sometimes miss them with animation. It can be achieved using a lot of time *Sméagol*, but there is a limited amount of time” (Peter Jackson; *Taming of*)

It is interesting to note at this point, that despite the opportunities provided by motion capture, the technology at this stage in time (2001) was not able to capture very small and intricate movements such as fingers and the face. Therefore, all animation done for these parts was applied in key-framed animation. Ultimately, a system was created which combined key-framed animation with motion capture performances.

5.4. How Gollum was Created

Three techniques were used in order to create the character of Gollum. Firstly, as mentioned above, a combination of motion capture and key-framed animation was initially combined in order to capture both the fictional and distorted Gollum who performed with the essence of Andy Serkis. For Gollum to interact with

the other characters, Serkis initially acted out what was referred to as *reference passes*, in which he dressed up in a white suit and interacted physically with the characters in order to teach the actors how to act as if Gollum was actually on set with them. However, Jackson soon found that the takes which included Andy Serkis, provoked a better performance from every character, both physically and emotionally. Thereafter it was decided to execute the performances with Andy Serkis included and to paint him out at a later stage. The CG character Gollum was then rotoscoped over his body to match his performance exactly.

The rotoscoping technique, like the motion capture, seemed to provide yet another advantage over the key-framed animation in terms of the creation of realistic animation. Without Andy Serkis in shot, the live actors had nothing to act off, which meant that performances became less than perfect. Additionally, subconscious actions were played out that would not be thought of consciously by both the animators of Gollum, as well as the actors interacting physically with Gollum. This technique became dubbed as *roto-animation* by the crew (*Taming of Sméagol*).

The system created for the animation of Gollum meant that body-wise, the animators had almost no creative freedom in how Gollum performed. For the majority of the film, Serkis was the driving force of the physical performance of Gollum. The technology at the time did not allow for facial or hand capture and this became the one element of Gollum that the animators could have freedom with. Using Serkis' performance as a reference, animators studied physiology and video, which allowed them to base their facial performance on realistic emotional reactions as well as create their own creative interpretations.

5.5. Performance Analysis of Gollum vs. Andy Serkis

The final result of Gollum's performance as well as the technology used proved to be successful to both audience and critics (Abbott 104). The technology to create *realistic* animated beings has been seen before, but not used in the same way as for Gollum. The success of Gollum was due to more than just the technology, but also Serkis' performance, because the audience could invest emotionally into the character he had created. It seems that the use of motion capture for the purpose of the film was necessary due to the fact that, as I have argued previously, in order to fit in and appear believable amongst live characters, Gollum's character required a higher level of realism. The use of a combination of motion capture and key-frame animation allowed for the exaggeration of performance when necessary, which ultimately would lead to a more exaggerated response from the viewers.

"The animation either came through by using motion capture or traditional key-frame animation. Initially animators were completely against motion capture.

"Because Andy movements on Gollum don't look like Gollum movements necessarily. Sometimes they do, sometimes they look great, but sometimes what he is doing is not as agile as Gollum could be" (Animation Supervisor; *Taming of Sméagol*)

There seemed to be two important aspects of Gollum's character that required the advantages of both techniques of animation. It was necessary for Gollum to appear *real* amongst the actors, but he also needed to have the ability to do what

humans cannot do. This implied that motion capture was limited in its advantages to the character. While providing naturalistic and subtle movement to the character, it lacked any appealing exaggerated performance. For example, shots such as Gollum climbing down a vertical cliff face, in the beginning of *Lord of the Rings: The Two Towers* (Jackson 2002), could not physically be done by Andy Serkis and therefore had to be fully animated in key-frame techniques.

This example clearly demonstrates the limitations of capturing performance as opposed to animating exaggerated performances. I would argue that the realism given to the mechanical movements was necessary for the believability of Gollum in the world that he was placed, however, I would also argue that it is the exaggerated animated performances that gave Gollum his unique character. A clear example mentioned in *The Taming of Sméagol* documentary of how this combination worked, is in *The Two Towers*, where a physical fight takes place between Sam and Gollum's character. Originally shot with Serkis in his white suite, Serkis performs a fighting head butting move which would often be associated in wrestling rather than a fight placed in a medieval fantasy world. Although most of the physical performance of Serkis was used for this part, the animators decided that the specific move mentioned above was not suited to the character of Gollum and instead decided to interpret the footage in a different way, making Gollum's CG character grab Sam's hair and shake it in a wild uncontrolled manner. The result displayed a more exaggerated and crazed Gollum, whose performance seemed more desperate and creature-like than Andy Serkis' performance and ultimately proved to be a more successful portrayal of the character Gollum.

In this case, as an animated character placed with live-action characters, the combination of both techniques allowed for Gollum to be believable within the world he was placed, as well as create the crazed fictional character described in the book. Ultimately he was a realistic character whose body had the capability to be distorted and exaggerated for more appealing and exciting physical performances.

5.6. Conclusion

In the case of Gollum, it seems both techniques were necessary for the successful portrayal of his character. Serkis' performance was not obsolete, but merely exaggerated by the use of technology. Here, motion capture gave Gollum the advantage of appearing naturalistic within his environment and was given the opportunity to act in a way that no other CG character could act, using motion capture's ability to capture subtle but telling body language. As I have shown in previous arguments, motion capture was also not enough to sustain Gollum's character on its own. Key-frame animation was required for facial and hand animation, as well as performances where Andy Serkis was physically limited. The face is considered to be the most important element for emotional recognition, and in this case, that emotional display was done entirely in key-frame animation. I would argue that key-frame animation's ability to exaggerate certain performances in a way that live action cannot, is a huge factor in the success of Gollum's emotional performance.

Chapter 6: Case Study

Jake Sully, Avatar

6.1. Introduction

James Cameron wrote the story of Avatar with the idea of CG animation in mind. However, the script was written in 1995 and was at the time impossible to achieve due to the amount of special effects needed and the lack of advanced technology to accommodate it (*Creating the World of Pandora*). James Cameron claimed in an interview that the story had developed as a result of the rise in demand for CGI in the future, and both him and his partner used the narrative as a way to push the technology further (Cameron; Interview)

The script was stored until cinema reached a time where performance capture could mature to a level in which the characters would not look entirely computer-generated. Once the technology had reached this point, movies such as the Lord of the Rings series became successful with characters like Gollum, and this is what had ultimately convinced Cameron to proceed with the Avatar script. As a result, two thirds of the film was created digitally.

6.2. Why the use of CGI?

Cameron stated his main reason for the use of CG animation was his choice of the aesthetics. He had the option to either place the actors in rubberized physical suits or to create CG characters. Previous films had proved that characters dressed up in suits could often cause a loss in the believability of the character, as well as subtle performances found in the face (Cameron; Interview). This implies that the physical costumes and animatronics devices could not achieve the emotional, subtle human performances needed, or move like a naturalistic bipedal human-like character. Also, I would argue at this point that CG animation can achieve more exaggerated performance than a human actor (in either live-action or animatronics), allowing the characters to achieve physical feats that are impossible to achieve from a real human. Abbott mentions the same advantage:

“The increasing presence of such cyborgs within particular cinema has gradually transformed other genres into a curious hybrid of the sf [Science Fiction] film. The bodies of actors can now be altered, extended, or made to perform in ways that defy the laws of nature, fusing the body with filmmaking technologies (101)... Nomaks cyborgs nature is conveyed through digital technology that creates exaggerated and “hyper-real” forms of movement, such as crawling up walls, leaping across rooms, and moving at accelerated speeds, all of which would be impossible without the use of CGI to digitally manipulate the movements of the actor.” (103)

This statement indicates CG's ability to not only transform the human body into another bipedal creature, but also the ability to give the bipedal character creature like or unhuman-like characteristics which cannot be achieved by a live-action actor. For a narrative where bipedal alien characters are physically taller, leaner, with cat-like ears and tails as well as have the ability to run faster, jump further, and climb better than any natural human, it was necessary to include CG technology. However, creating naturalistic skin, mannerisms and textures of human-like features is one of the biggest challenges of CG animation. Avatar had to have alien characters that were realistic enough to blend in with the physical laws of nature. As I have mentioned before, Avatar's characters managed to avoid the dangers of the Uncanny Valley due to the fact they are not actually human and therefore we do not judge them with the intense expectations as we do when viewing CG humans. This allowed the creators of the Na'vi to experiment with the human body and extend it into fresh shapes that have never been seen before.

6.3. Motion Capture in Avatar

Despite Gollum's great success in CG character performance, there was still a lack of performance capture for the face and therefore the face was allowed more creative freedom from the animators, instead of a manual transcription from a performance capture system. Cameron believed that this method did not produce the level of reality that he expected from the Avatar characters:

"We had to make a quantum leap forward in the way the facial performance was done, because we still weren't seeing kind of humanoid facial performance that looked real enough for me emotionally. And so we came up with the head rig... and from that, you can extract everything – the eye movement, the lips, the tongue against the teeth, which is critical to the performing of certain sounds." (James Cameron, Interview)

The faces of the Na'vi were lined with markers for motion capture tracking, but the results usually attained from this method were not realistic enough for Cameron. Therefore, a head rig with a video camera which filmed the face independently from the body allowed for precise and accurate analysis of how the human face moves. This meant that accurate and realistic facial animation could be produced, with not much room for creative animation. This method managed to overcome limitations created by marked motion capture, by allowing certain movement to be examined, such as eye movements. (Cameron; Interview)

This did, however, mean that the creative process for animators was completely limited and they were only allowed freedom with the ears and tail, the only appendages that are not part of the motion captured actors. This also meant, however, that Cameron had the ability to direct the film as if it were a live-action film, because the motion capture system allowed for real time viewing of the characters in the virtual environment. This process implies that Cameron was not interested in exaggerated performance, in the sense that key-framed animation creates exaggerated performances, but rather something that would appear completely realistic and comply with our physical laws the way that live-action actors would. The characters as well as the environments were fantastical, which the medium of animation was successful in achieving, however, realistic performance became a main focus of the film.

6.4. Performance Analysis of Jake Sully vs. Sam Worthington

“We needed to get to the far side of that dip of the response curve which is called the Uncanny Valley and we needed to get to the opposite side where we believed, we don’t have to necessarily believe that it’s a hundred percent photo-real and we don’t have to necessarily believe that they actually exist. But we have to believe in them as emotional creatures. I think we’ve absolutely accomplished that” (James Cameron; interview)

I would argue that Cameron and the team of Avatar were successful in crossing the Uncanny Valley as stated above. The CG performance and subtlety created by the facial performance is some of the most realistic to-date, and despite appearing completely strange in comparison to humans, featuring bright blue skin, ears, tails and unnaturally long skinny bodies, the animation appears realistic enough to appear believable within a world that is governed by live-action physics.

This also meant that what was seen on screen was a manual transcription, for example, of Sam Worthington’s performance into Jake Sully’s Avatar’s performance. All mannerisms made from Worthington, such as the flicker of eyes, subtle facial performances, the unique way in which the character would smile, speak or laugh, were transferred into the character of Jake Sully. The Avatar resembles Worthington aesthetically and the character has merely become a digital costume for the actor. This meant that the performance and appearance of the character would be more believable to an audience who have been weathered to seeing special effects costumes in older

cinema. In terms of this factor, the method and use of performance capture for the film was largely successful and also allowed certain advantages over live-action.

Not only could Sully's character defy gravity, jump and stretch beyond his body span and physical limits, but could also be open to any tweaking needed by an animator, at the request of Cameron. The performance capture allowed the audience to view realism in unrealistic characters as it had never been seen before.

6.5. Conclusion

Avatar became the highest grossing film of all time, earning over two and a half billion dollars, and had the ninth biggest opening. This fact in itself is proof of the increasing demand for realism in animation today and probably for the future. However, many people would still argue that Gollum's character and performance was far more entertaining and endearing in comparison. This could easily be due to the factor in the previous discussion, where it was put forward that stylised and exaggerated performances could result in heightened responses from the audience. Although it is impossible to decipher which character was more popular, it is clear that audiences invested emotionally in both characters to a high extent. Furthermore, both characters were part of the special effects side of animation and had to present a high level of realism in their animation performances. In these cases it was successful and it seems the pursuit for realism will increase continuously in the future.

CHAPTER 7: CONCLUSION

There has been a pursuit for realism since the creation of computer generated animation. It seems, however, that the effort to achieve the level of realism that often faces the danger of the Uncanny Valley has only been necessary in animation used for special effects of live action films. It is true, as the Disney animators and Paul Wells argue, that a semblance of reality is needed in an animated feature in order to hold an audience's attention for the entire duration of the film. But this argument was specifically put forward for films that were intended to be fully animated. Here, realism in animation is described more as "verisimilitude" and as the "caricature" of reality rather than being "realistic" in the complete sense of the word.

Animation is not a data recording of reality, but rather a representation of it. Nevertheless, these ideas begin to change when the effort for realism is pursued in the category of animation as special effects in live action films, as animation serves a different purpose in live action. Here, animation is a method in which to replace or describe fantastic events in the real world. The animated character replaces the stunt double in dangerous scenes, or places an imaginary creature into the world that cannot physically be recorded by

live action camera. In such cases, it has been necessary to reach a high level of reality within the animation, as the audience needs to be convinced that it is possible that these fantastical characters and events can exist within our realm of reality, along with live action characters and locations. The moment an unrealistically animated character exists within a narrative alongside real humans, in a way that the character is introduced as something that is part of our world and obeys physical laws of our world, the audience is drawn to and made aware of the fact that the character is not real and therefore a sense of disbelief is developed.

However, this problem does not occur as often in characters that are not human. Humans are extremely sensitive to how another human should move and behave. We are subconsciously aware of subtleties and small nuances found in human conduct, and therefore, human characters are judged more harshly. A non-human, anthropomorphic character, such as the Na'vi as well as Gollum, do not face the same abrasive assessment, as we do not frame these characters as "humans" and therefore view them accordingly.

In the same way, characters within fully animated films are only judged within the frame of mind we have placed them in. Realism in animation film has proven to be neither necessary nor more appealing than traditionally animated film. The world created in animation is unlimited and not necessarily bound to the physical laws of the real world. Any rules may be established in this fantasy world and, therefore, any character (including unrealistically animated humans) may fit into it. Films such as *The Polar Express* were not successful because the animated humans were introduced as 'real humans' placed in the real world, obeying realistic physical laws, and therefore were judged in the 'realistic world' frame of mind.

Nonetheless, David Bennett argues that the reason that realistically animated characters have fallen into the trap of the Uncanny Valley in past films is solely because the technology had not developed enough at that point to cope with realism successfully. Motion capture technology, as well as Image Metrics' facial analysis technology has since developed far enough to create animated human characters that have managed to cross the Uncanny Valley, and in the case of Image Metrics, have made the animated human indistinguishable from the real human.

This has created tension between animation used as mechanical transcription and also artistic abstraction. Where motion capture has developed such accuracy that the animation virtually seems like a literal capture of data, traditional animation techniques have been used in conjunction with it in order to create an appealing product. Therefore, whilst motion capture has been successful in creating accuracy of movement in the body, especially the face, where key-framed CGI animation has struggled, it is not sufficient on its own in today's standard of animation. Most professional film companies, such as Weta Digital Studios and Image Metrics who use motion capture and facial analysis systems, also use Paul Ekman's FACS theory in order to achieve the high quality of animation. The amount of motion capture used in each work may differ depending on its purpose within the film and how much realism is needed as a factor in the film. Yet despite this, key-framed animation theory has been applied to it to create the illusion of life and provide the ability to create what motion capture could not record.

Animation is placed into a frame of mind in which we expect certain rules and conventions to apply, thus too much detail within a character's movement can be read as strange to the viewer. Recording such realism is not always necessary in an animation film

and therefore, motion capture should perhaps only be used as a reference for timing and performance rather than the final recorded data. In films where realism is expected in order for unrealistic characters to blend into the real world, animators may rely more heavily on motion capture and similar technology. In either case, successful and appealing animation has been born through a combination of both.

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