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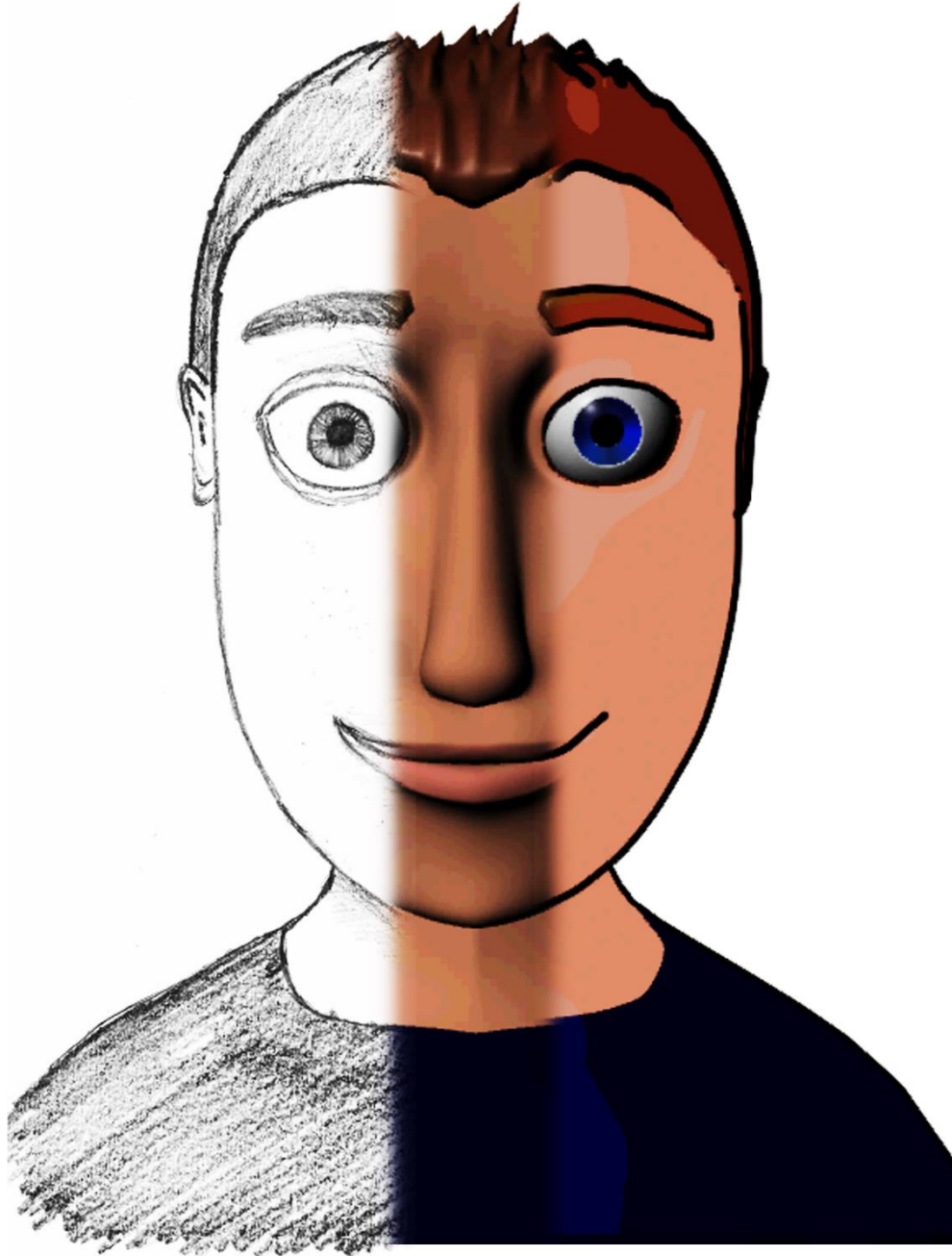# The Aesthetic Impact of Hybrid Animations of Humanoid Characters

by Niels Henrik Breiner Sørensen

Contents

Introduction

The evolution of animation has come from the concept of showing images with slight differences in the image to simulate motion to being able to create almost photo-realistic scenarios using 3D animation. The art form of drawing and sketching was a great part of animation for many years, but within the last decade 3D animation has grown in popularity and the traditional hand-drawn animations have become less popular, however it can be argued that the traditional hand-drawn animation as an art form can convey information better than the modern 3D animations and in recent time some productions have been made that combine elements of both types of animation. In 2012 Walt Disney Animation Studios released an animated short called Paperman. The short was received with praise and it even won an Academy Award for Best Animated Short Film at the 85th Academy Awards. One of the ways this short stood out was due to its unique graphical style; it was a black-and-white 3D, hand-drawn and computer animated short film that combined the technology of computer generated 3D animations and the style of hand-drawn animations. I watched the short and was immediately captured by the story and also this unique attempt at combining the art-form of hand-drawing with the newer media of computer generated 3D. Having being raised with the classical animated feature films from Disney, I have always been fond of them and fascinated by how the animators could convey such emotion with just lines and colour and in this case how two unique art-styles could be combined. Due to my interest in both the traditional hand-drawn animations as well as the more modern computer generated 3D animations I decided to research how the combination of these techniques can affect visual aesthetics of the viewer by being presented by such a hybrid style. I believe it is relevant to preserve the art-style of hand-drawn animations, but I also find it important to research how traditional art-styles can be combined with newer ones and how this will impact the viewers. This was my motivation for creating my master's thesis.

Pre-Analysis

Based on the motivation from the introduction an initial problem statement was formulated

Initial Problem Statement

Can cartoon inspired graphical concepts used on a 3D humanoid
character model make the viewers perceive it as more likable?

Perception

After defining an initial problem statement several main areas of the problem statement would have to be researched. The following will briefly run through the biological and psychological aspects of perception; however it will be limited to visual stimuli because of the focus of this project being visual.

The concept of perception originated from the research done in the nineteenth century describing the process of how the brain and the senses work. Originally the research that was done was focused on animals because the scientists very early on drew the parallel between human and animal biology and agreed that the research done on animals could mostly be applicable on humans as well. To understand the basics of vision one must first know that light is in fact a form of electromagnetic radiation (Wolfe, et al., 2009). Light can be conceptualized as one of two possibilities; as a wave or as a stream of photons, that are small particles of energy. Generally light is easiest understood when referring to it as waves when it moves around and as photons when it is absorbed, for instance by the eye (Wolfe, et al., 2009). The full spectrum of what we know as electromagnetic radiation is very wide and only a small fraction of this full spectrum is possible for human eyes to see; the waves humans are able to see have wavelengths between 400 and 700 nanometers which places the visible spectrum in between ultraviolet and infrared light as seen on Figure 1. In order to see and therefore perceive the world around, light needs to enter the eye and be absorbed by the viewing cells in the retina by being transduced into neural energy (Wolfe, et al., 2009).
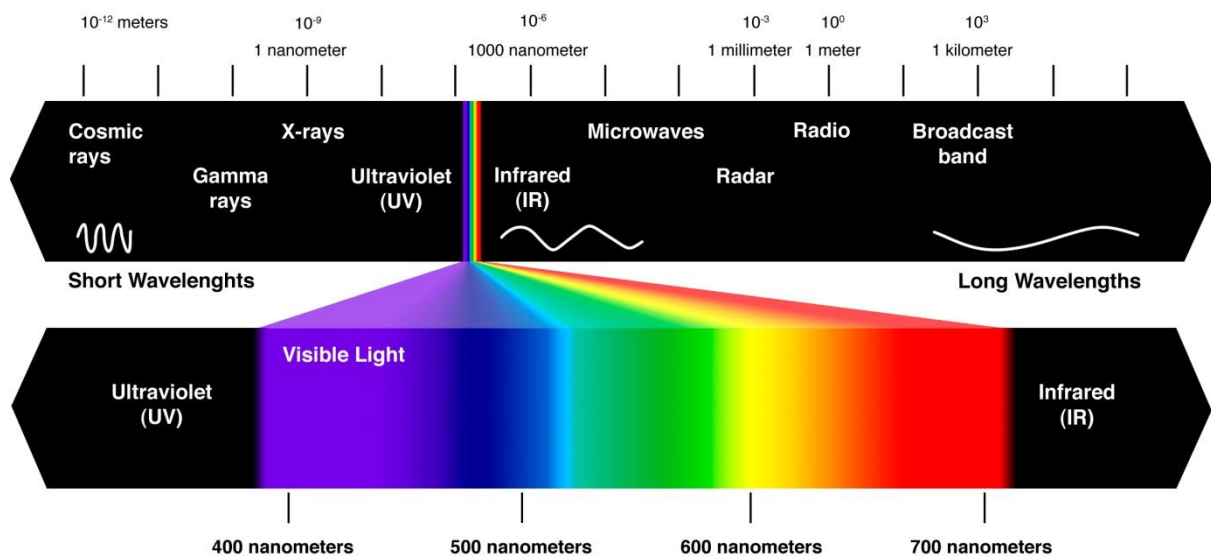

Figure 1 Showing the location of light visible to humans compared to the full spectrum

All of the senses that humans possess are based on the concept of transduction, which is

> "the conversion, by sensors in the body, of physical signals from the
> environment into neural signals sent to the central nervous system."
> *(Shacter, Gilbert, & Wegner, 2011)*

In short it is energy from the physical world interpreted by the receiving sensing organs and converted into neural energy in the central nervous system. For instance like it was just mentioned about how the eyes absorb photons and convert them into neural energy. The further process of how the brain interprets these signals will not be elaborated since the project has no great need of this. It will however briefly be discussed how the brain creates groupings when perceiving visual stimuli.

A concept known as unconscious interference within the field of visual perception was discovered based on the research done by Hermann von Helmholtz. He had discovered within his studies that the human eyes are actually optically somewhat poor and concluded that the human visual perception was made

Figure 2 The character Belle from Disney's Beauty and the Beast

possible by a sort of unconscious interference based on assumptions and conclusions made from incomplete data based on previous memories and experiences. Some of these assumptions based on previous experiences are often closely connected to nature, for instance; light typically comes from above e.g. the sun and closer objects can block objects positioned further away by being within the line of sight. These pieces of information are hard-wired into most humans and are part of what makes our sight possible. A good example of this that is in relation to this project would be the contour lines and shading used on Disney characters. As it is seen here on Figure 2, the character Belle from Disney's Beauty and the Beast[1] has a black line that shapes her chin and a slightly darker shading underneath the chin, suggesting to the viewer that the chin is closer to the camera than her neck is and thus the chin casts a shadow on the neck since the light is shining from above. These pieces of information are frequently used in cartoons to simulate reality making the viewer able to fully

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[1] Beauty and the Beast – Animated film produced by Walt Disney Feature Animation and distributed by Walt Disney Pictures

understand what they are watching by adding simulated realistic optic phenomena. An analysis of the graphical design used on some Disney characters will be discussed later.

Animation

Having researched how the human eyes receive information it was then necessary to research some of the various forms of animation. There are additional types of animation, but the types that are mentioned in the following section were the ones that were deemed the most influential and most important for the project.

Different types of 2D animation

Classic Hand-drawn Animation is created by drawing every image with all details needed or alternatively by using a technique called cels[2]. The concept of using cels saves time by some parts of every scene being able to be repeated; for instance in a scene where only the characters move but the background is not needed to move; the background could be created and then only the characters would be animated in front of the cel with the background on by utilizing that the cels are translucent and thus creating a composite-image[3] based on several drawings. This technique also allows the backgrounds to be very detailed without having the artist paint the entire background in
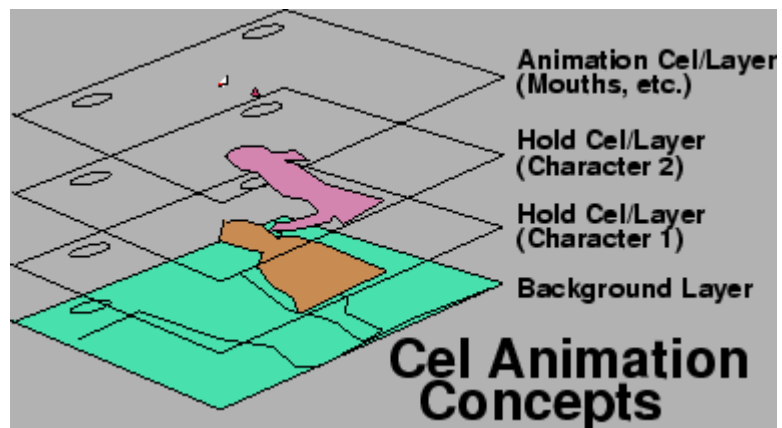
Figure 3 Showing the concept of Cel Animation

detail for every frame of the animation. See Figure 3 that illustrates how the translucent cels are used for this technique (Hachigian).

Another 2D animation technique that is used frequently on the internet is animation using a program called Adobe Flash; an animation technique like this is mostly referred to as Computer Assisted Animation. It allows the animator to create animations by only drawing the key-frames and letting the program create the in-betweens. This technique allows for less work than if all the in-betweens would

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[2] Cel being short for Celluloid – A transparent sheet
[3] Composite-image – An image comprised of individual parts assembled into a single image

have to be drawn instead of the process being handled by the computer and the program. Additionally Flash animations can appear very smooth compared to animations with fewer frames per second since they would have to be created by hand individually and the artist will also be able to work with vector graphics and thus the images could appear much smoother in detail (Simpson).

Different types of 3D animation

Computer animations are a type of animation that is created exclusively on computers and are thus digital, they are often referred to as CGI[4] Animation. Technically animations made in Adobe Flash are also called computer animation, but in this case computer animation will refer to images with simulated depth (3D). This animation technique has the advantage of being the one that is closest to resemble photorealistic images by including calculations of light and even automated movement of for instance foliage being moved by wind using physics formulas (Roos).

Another animation type that sometimes creates images with a great sense of depth is Stop Motion Animation. Examples of this type of animation are for instance Tim Burton's The Nightmare Before Christmas[5]. A popular technique to create Stop Motion Animation is by using clay or other moldable materials, creating a character and taking a picture of the character and then for every frame changing the character a small amount (Brown, 1993).

For this project the most interesting types of animation are the classic hand-drawn animations and the computer generated 3D animations since the focus will be how techniques from the classic 2D hand drawn animations can be simulated in 3D. In the initial problem statement the term cartoon was mentioned but since the term animated cartoon is mostly used when referring to animated shorts and not full length movies like for instance Disney's Beauty and the Beast or Aladdin; from now on in this report the cartoon style will be referring to the style seen in animated feature films (Laybourne, 1998) (Nethery).

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[4] Computer Generated Imagery
[5] The Nightmare Before Christmas – A stop-motion animation film directed by Henry Selick and produced by Tim Burton

Analysis of Animated Humanoid Disney Characters

It was deemed necessary to research how some of the popular Disney characters had been designed and created. The following is an analysis of the design and visuals of some popular characters from animated Disney movies. The analysis of the characters' design and visuals are based on analyzing images and footage from the movies from which the characters appear in.

Aladdin

The character Aladdin from Disney's Aladdin[6] can be seen on Figure 4. The character has been designed with mostly soft shapes and even though he is clearly a male character he was not designed with overly masculine traits so he appears youthful. The character features large round eyes and simple lines that form the character's mouth and nose. The contour lines that have been used are mostly dark or black except for in his hair since black lines would not be visible in the black shape that his hair consists of. The shading of the character is simple and shadows appear to be a slightly darker color of whichever part of him that needs to have a shadow cast on, for instance his vest has a slightly darker shade of purple to illustrate a shadow area.

Figure 4 The character Aladdin from Disney's Aladdin

Belle

The character Belle from Disney's Beauty and the Beast[7] can be seen on Figure 5. The character was designed with very soft curves, much like the character Aladdin, however with a much rounder face. Her eyes are large, but less round than Aladdin's. Her features, like her eyebrows and eye-lashes were designed to be very feminine like for instance; her nose is rather small but she has very full red lips. The shading of the character was done much like with Aladdin and shadows are shown by a

Figure 5 The character Belle from Disney's Beauty and the Beast

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[6] Aladdin – Film produced by Walt Disney Feature Animation and released by Walt Disney Pictures in 1992.
[7] Beauty and the Beast - Film produced by Walt Disney Feature Animation and distributed by Walt Disney Pictures in 1991.

slightly darker tone. Contour lines are very dark or black except for any contour lines that are featured on her very light coloured clothes.

Phoebus

The character Phoebus from Disney's The Hunchback of Notre Dame[8] can be seen on Figure 6. The character was designed to have very masculine traits; like a very strong jaw, a large nose, big bushy eye-brows, a wide neck and facial hair on the chin. Compared to Aladdin and Belle the character's eyes are small so he would not appear as sympathetic as the two previous characters. The techniques used for both shadows and contour lines were the same as used for the two previous characters, however due to his hair being a very light colour the contour lines in his hair are a dark brown colour.

Figure 6 The character Phoebus from Disney's The Hunchback of Notre Dame

Ariel

The character Ariel from Disney's The Little Mermaid[9] can be seen on Figure 7. Even though the character Ariel is not a human her design can still be taken into account due to her appearances from the waist and up appear to be human even though she is a mermaid. Her design is much like Belle, but her eyes are even bigger to make her appear young and innocent. The shading is used as the other examples and the contour lines are primarily black.

Figure 7 The character Ariel from Disney's The Little Mermaid

To summarize, the design of the humanoid characters from these 4 hand-drawn animated feature films focus on exaggerated features and shading is done with 2 tones. The contour lines are mostly black or dark unless the areas the contour lines are affecting are black.

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[8] The Hunchback of Notre Dame – Film produced by Walt Disney Feature Animation and released by Walt Disney Pictures in 1996.
[9] The little Mermaid – Film produced by Walt Disney Feature Animation and distributed by Walt Disney Pictures in 1989.

Aesthetics

Following the analysis of the graphical style of the four Disney characters the final part of the initial problem statement would have to be researched and as such it was deemed necessary to research what makes something aesthetically pleasing or likeable within visuals.

The word aesthetics regards a certain philosophical branch that focuses on beauty. The Oxford Dictionaries defines it as; "*giving or designed to give pleasure through beauty; of pleasing appearance*." (Oxford) This definition however focuses on the visual aspect of the concept, but since the nature of this project is in visuals this definition fits well in what will be defined as aesthetics within this project.

One of the issues that have been discussed over the years within visual aesthetics is that it is not universal. A person's appreciation and taste within what is beautiful is a very personal aspect based highly on culture and because of this the value of beauty can be general but not universal (Zangwill, 2003). In the 18th century, Scottish philosopher David Hume argued that humans have a form of general taste principles, he wrote "general principles of taste are uniform in human nature", that if human nature was not uniform across cultures and ages, it would not be possible to enjoy the previous works of arts that have survived history. Hume suggested a criterion called the "test of time". This theory also focuses highly on the fact that many works of arts over the ages have many features in common in both subjects and how they were executed, suggesting that preferences within taste, art and aesthetics do not change based on the cultures or time.

However in the twentieth century, art theorists began to move away from the opinion of the previous theories that involved the general taste principles and instead focused on theories that say that art would be interpreted based on the historical and cultural context of when it was produced. These theories followed the theory that the human mind is a complete blank slate when created and it possesses a capacity to learn all skills, abilities, values and knowledge that the cultures it would be exposed to could teach. Mid-twentieth-century aesthetics followed the same pattern and it was believed that: "*Aesthetic values were regarded as whatever culture taught was aesthetically valuable; aesthetic values and meanings were considered without residue constructed by culture, and works of art were both created and appreciated within the norms and conventions of culture.*" (Dutton, 2005) So in short, the theorists had gone from being certain that there existed a sense of aesthetic universalism to the exact opposite that the context of culture was a great factor of aesthetics.

Evolutionary Psychology: Natural Selection

Recent research has through the work within evolutionary psychology more or less dismissed the theory about the human mind being a blank slate from the start because of how evolution has functioned.

> *"… evolutionary psychology posits the existence of innate interests,*
> *capacities, and tastes, laid down through processes of natural and*
> *sexual selection."*
> *(Dutton, 2003)*

Based on the functions of early Homo Sapiens it is argued that the human mind has pre-existing tendencies that have evolved specifically for the survival of the race; from the hunter-gatherer communities that homo sapiens came from where it was a direct advantage like for instance the ability of sensing food purity and contamination, interests within child-nurturing and even natural phobias like the fear of spiders, snakes and other poisonous creatures. In regards to aesthetics it is highly interesting that there has not existed any known human culture that have not shown any sort of expressive makings.

> *"The very universality of art strongly suggests that it is connected with*
> *ancient psychological adaptations."*
> *(Dutton, 2003)*

A study where test subjects of different ages from various cultures, were shown various kinds of landscapes showed a very interesting tendency. Among the adult test subjects no landscape stood out significantly as preferred, but young children showed a clear tendency of a preference to the savannahs with trees; such a landscape that theorist still believe where the human race's early evolution took place, in Africa. The concept that young children would have a clear preference for this landscape, that would be the most ideal landscape for the hunter-gatherer community that the human race primarily was based on, is a clear indication that there does exist a pre-existing preference and mindset in human beings, this is also highly relevant in the search for a mate.

However based on the fact that a universally aesthetically pleasing being cannot be specified it would be more interesting to focus on how previous memories or similar can possibly affect how a character is perceived.

"Our attitude towards a work of art, an object or an event, as it is stored in memory, may determine its

evaluation... ...This is also often the case for aesthetic evaluations."

(Jacobsen, 2010)

Based on this, a character that mimics specific traits of something the test subject has fond memories of could possibly make the user perceive the character as more likeable/aesthetically pleasing because the perception of the character would be affected by the previous memories. For instance; many of the people that grew up in the period known as Disney's Renaissance; from 1970 to 2000 (Greydanus) were brought up with the cartoons produced by Disney and as such it could be possible that many would have fond memories of the characters both in how they appeared but also how they were presented in terms of the cartoon style. This theory will be referred to as the Theory of Memories within this report and will later be discussed further.

To conclude upon the theories of aesthetics and of likeability it has been argued that a universally aesthetically pleasing or likeable being cannot be specified based on the nature of taste, however further research in the area could possibly lead to some general design pointers for creating a humanoid character.

Based on the research that was made within the Pre-Analysis a Final Problem Statement was formed. The theory of memories that was briefly discussed in the Pre-analysis would be the theory the research of this report would attempt to uncover. Based on the research on aesthetics and what makes visual stimuli aesthetically pleasing and likeable a more concrete Problem Statement could be formulated with a more focused area of interest.

Final Problem Statement

What is the aesthetic impact of hybrid animations of humanoid characters, i.e. cartoon inspired

graphical concept applied to 3D animations, by employing the theory of memories for creating

associations to previous experienced cartoons?

Analysis

Having formulated a final problem statement some more direct research could be completed. It was deemed necessary to further research Aesthetics as well as the Theory of Memories that was briefly mentioned in the pre-analysis. Since the area of interest in the project was the creation of humanoid characters it was also deemed important to research the theory of the Uncanny Valley, a theory that highly affects design choices when creating humanoid characters. Lastly it would also be important to research current and pre-existing work that had been done within similar fields of work.

Aesthetics

In the pre-analysis the initial theory and definition behind aesthetics was researched and discussed, in order to fully understand aesthetics the research is continued here and discussed further and the Theory of Memories will be discussed afterwards.

Within evolutionary psychology aesthetics are also relevant and many parallels can be drawn within the fields. One of the most famous examples of natural sexual selection is with the peacock. The male peacock sports a large tail with bright colors as seen on Figure 8 and the female peacocks use these to assess whether or not the male is the ideal choice of a mate. The tail is big and heavy and
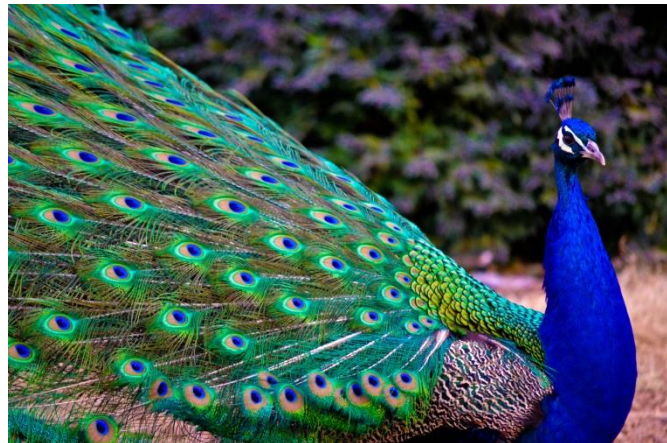
Figure 8 The male peacock with its large, brightly coloured tail

takes considerate amounts of energy for the peacock to grow, it is very much not an advantage in a survival aspect, but because of this it shows the female peacocks that the male with the most impressive tail can overcome the obstacle of the tail and thus being the optimal choice for the female to produce and therefore the tail is a fitness indicator. Generally fitness indicators are signs the females look at on the males; signs of strength, cleverness, intelligence and genetic fitness. The fitness indicator is mostly displayed on the males and observed by the females, but in some races it is the other way around. Fitness indicators are not only apparent in the animal kingdom but also within humans however there is a greater case of mutual choice within humans in regards to the sexes.

Sexual selection has the effect that the traits of the previous generations will affect the next generations and even in regards to taste and preferences. The Wodaabe of Nigera and Niger have a tendency of preferring the males that are the tallest, have the biggest eyes, whitest teeth and straightest noses and have as such over generations grown taller, with big eyes, very white teeth and with very straight noses because of the preferences also being inherited over the generations compared to the neighboring tribes. The same can be seen based on the current generations, our ancestors held personal qualities of being witty, intelligent, creative and generous very high and as such it can be seen in the current tastes and traits in other human beings and how we create and appreciate art (Dutton, 2003).

Physical attractiveness is how a person's physical traits are within humans deemed beautiful or aesthetically pleasing. Physical attractiveness does not necessarily imply sexual attractiveness as a person can experience attraction to another person without any sexual attraction. This is a very relevant point since the focus of the project is not about sexual attraction.

"Body symmetry – a well-known fitness indicator"

(Dutton, 2003)

The various physical traits that are mostly seen as generally attractive, but not universally and not based on the culture or time are; facial- and body-symmetry, with a slight offset since absolute flawlessness in the symmetry can seem disturbing. Asymmetry tends to signal past injury or illness and therefore human beings are in a way programmed to deem asymmetry as being less attractive, this makes sense in the evolutionary aesthetics that were discussed earlier where most animals will favour the individuals with the best possible genetic pool for further offspring and therefore the continuation of the race, and traits like asymmetry that could mean illness would therefore be an evolutionary disadvantage. Some of the traits that are mostly agreed upon as being deemed physically attractive are; youthfulness, skin clarity, smoothness of the skin, vivid and intense colours' of eyes. However based on both cultures and the time many individuals have different tastes and as such a universally physically attractive being cannot be specified, but some few guide-lines can be made as to how one would define a person that would be deemed aesthetically pleasing for a relatively large group of individuals.

The concept of time-based aesthetics is that within periods of time where factors within human life has changed so has the aesthetic judgment as well; for instance aesthetically pleasing aspects such as how the ideal body shape has changed based on availability of food etc. This can easily be seen within art from different ages depicting women with more curves as the ideal for periods where plenty of food

could have been a luxury limited to the richest and most powerful families, compared to recent times where the large amount and availability of food has changed the general body ideal to that of a slimmer figure compared to earlier within history. In order to limit the extent of the project it was decided that the focus would be that of the head, neck and shoulders and as such the factor of body aesthetics would not be researched further.

The Theory of Memories

In the Pre-Analysis a theory was theorized stating that previous experiences affect the judgment of new ones, in regards to aesthetic judgment.

"Our attitude towards a work of art, an object or an event, as it is stored in memory, may determine its evaluation... …This is also often the case for aesthetic evaluations."

(Jacobsen, 2010)

Previous experiences affect how a person perceives and judges new ones. Even though a person experiencing something completely new that does not resemble any previous encounters it is still seen based on the context the brain has gathered. A person shown a red, round object might immediately recognize the object as whatever the object might be if the object has been encountered before, for instance a red apple or a red ball, but if the person is shown a red object that the user has never seen before the persons brain will still try to categorize the object based on previous encounters even though no pre-existing data exists in the brain to categorize it. The brain will then try to categorize the object anyway, based on shape, texture, colour and even context and will eventually place the object within a category that the object has the most in common with (Huth, Nishimoto, Vu, & Gallant, 2012).

Based on the way humans perceive objects, the world and even other human beings in combination with these theories of how the human brain categorizes visual stimuli based on common factors and how memories affect the aesthetic evaluation and encounters of new experiences it should be possible to create an experiment that would use the combination of these theories to actively see if the users who grew up with a specific media will accept a newer media when by simulating the older media on the newer one. In this case by using graphical concepts that would normally appear in classical hand-drawn animations on computer generated 3D characters. Based on this theory the testing scenario in this report was created, stating that the so called hybrid animation principle will make users who prefer the classical hand-drawn style perceive the newer computer generated 3D character as more likeable and aesthetically pleasing by creating associations to their preferred older media.

The Uncanny Valley – The Choice of Stylization

A theory that originated within the field of robotics that is highly relevant for this project is the Uncanny Valley. In the 1970's a Japanese roboticist named Masahiro Mori, started creating robots that had more human-like characteristics than robots had previously had within the field. Initially his robots were met with positive responses however as he continued trying to create more human-like robots he discovered something. He reached a point where people would respond increasingly negatively to his robots because of their added human characteristics. He discovered that when the robots had so many human characteristics that they started looking like humans people would distance themselves from them and even find them revolting and unsettling because the robots would look almost like real human beings, but not quite and thus what the robots were lacking became a greater issue. This entire issue led to the formulation of the theory of The Uncanny Valley that stated that as the human likeness of the robots increased the familiarity increase as well, however at some point the familiarity will drop drastically forming what is called the Uncanny Valley as seen on Figure 9. If the human likeness however increases even more the theory states that the familiarity will rise as well (Levy, 2004).
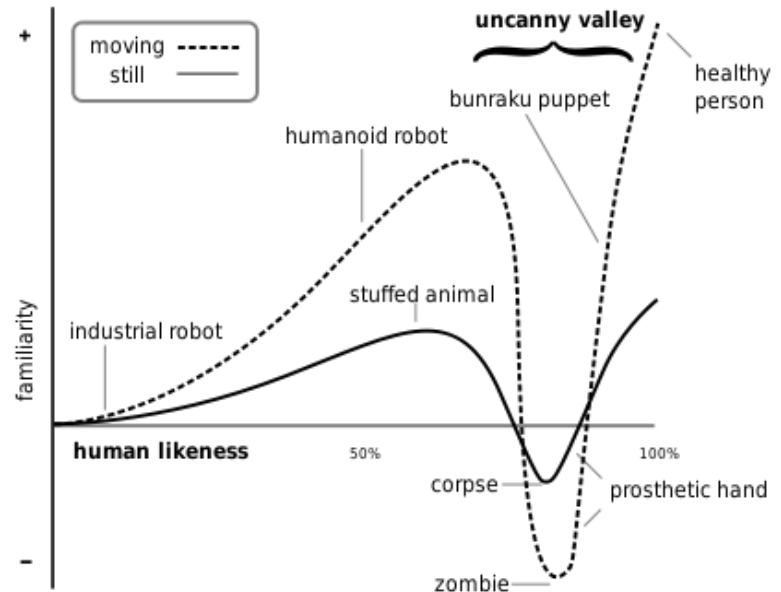

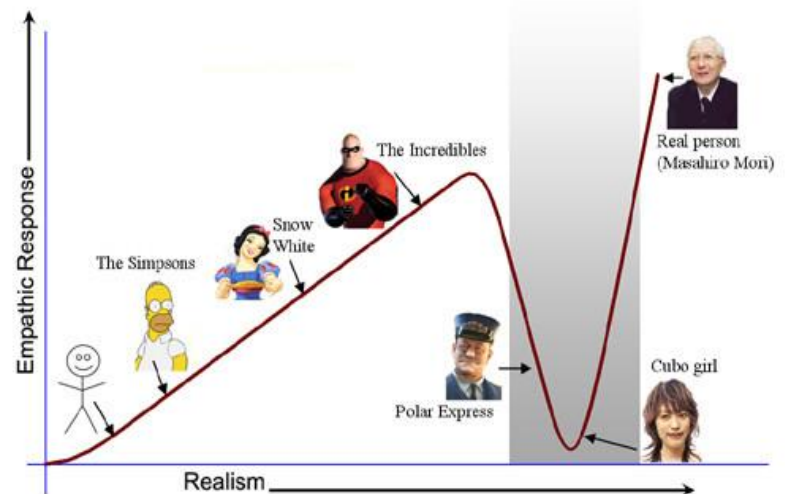Figure 9 The original graph depicting the Uncanny Valley

Figure 10 The Uncanny Valley Graph depicted with humanoid characters

The theory can also be applied within the field of animated humanoid characters as seen on Figure 10. Within animation the theory is relevant because when creating a humanoid character it should be decided early on whether or not to aim the design for the peak before the uncanny valley or the peak after. The peak before can for instance be a stylized look like the characters in Pixar's The Incredibles[10], where the characters are clearly supposed to be humans, but because they are highly stylized with exaggerated features they do not fall into the uncanny valley (Seyama & Nagayama, 2007). The reason why the Uncanny Valley is relevant for this project is because when designing the character for the product the theory should be taken into consideration in regards to possibly making the character stylized to avoid the uncanny valley.

State of the Art

It was deemed necessary to research some of the previous work that had been done that would be relevant to the work of this project. The chart below, Figure 11, shows how the works discussed relate to each other and the project in terms of both media and technology used to create the graphics.
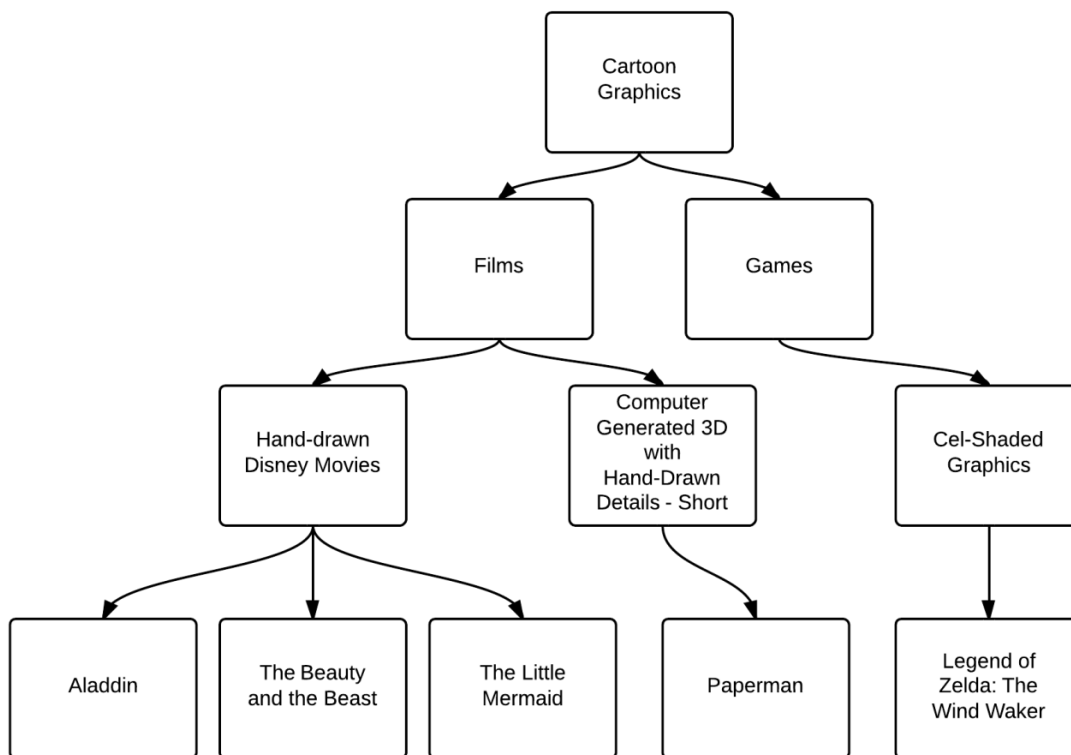

Figure 11 Chart showing how the State of the Art relate to the project and each other

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[10] The Incredibles – Film directed by Brad Bird, released by Walt Disney Pictures, and the produced by Pixar Animation Studios

The Walt Disney Company was founded in October 1923 by Roy and Walt Disney and is commonly referred to as Disney. The company has produced numerous cartoons since then and is mostly known as the company behind some of the most aesthetically pleasing cartoons made. The company has for many years held pride in producing high quality movies and shorts and is often critically acclaimed for beautiful animations, character designs and generally likeable characters in all aspects. Earlier four characters from some of the popular hand-drawn animated cartoons Disney had produced were analyzed to uncover how they had been designed and created.

The video game The Legend of Zelda: The Wind Waker, developed and published by Nintendo in 2002, used an art style and graphic technique called cel shading that made it appear as it was some sort of cartoon in combination with a character design featuring large eyes and other features that would otherwise primarily be used for cartoons. The choice of using this art style over the traditional shading techniques that had been used in the other 3D installments in the series was met with praise especially because it felt new and fresh. The techniques that were used to make the main character seem likeable would be a possible design solution when creating the product for the report.

Paperman was a short produced by Walt Disney Animation Studios and was released in 2012. The short combines traditional animation techniques and principles with 3D animation to create a very unique feel. The reception of the short was positive from most critics and it also won an Academy Award at the 85th Academy Awards for Best Animated Short Film. The short features a love story between two young people and the entire story is conveyed without any spoken words. The two main characters appear highly likeable and the general look of the movie was highly praised and even though the exact look of the movie would not be possible to recreate due to both the lack of skill as well as time, however the techniques and design choices used in the production would be highly relevant to take into account when designing the product for the test.

The Cartoon Style versus Traditional 3D animation

It was deemed necessary to research and explain the graphical differences between the traditional computer generated 3D animations compared to the hand-drawn cartoon styles Disney used primarily in the time period of 1970 to 2000.

The cartoon style that will be discussed in the following section would be that of a stylized cartoon style, e.g. like Disney's Aladdin, Beauty and the Beast and The Little Mermaid. The choice of these cartoons for comparison has been based on the nature of the project to differentiate the 3D models from traditional

3D models. Some of the most obvious differences between how cartoons appear compared to traditional 3D animation is the level of detail. Cartoons often have fewer levels of colour to simplify the creation process, whereas traditional 3D animation utilizes textures that are mostly detailed because even when animated the texture will move with the model and allows for more detailed surfaces of the models.

In computer animated scenarios lighting can be simulated in a relatively realistic sense, including how light would bounce between objects' surfaces and even concepts such as subsurface scattering[11]. Within traditional animation lighting is comparatively more simplified since the computers would be able to do the calculations necessary for the lighting in the animations whereas in the cartoons the person drawing the images would have to have knowledge and plan out the scenario of how the light would move in a much greater degree to even come close to realistic lighting.

As mentioned earlier within stylized cartoons lines are often used to contour the character to differentiate same colored parts of the body to create a sense of depth in the image, this technique is often needed to separate the different parts of the body on the characters along the lines with soft shadows because the surfaces and textures are often the same color and shade for every body part.

The primary differences that will be focused on in this project therefore are:

- More advanced textures VS Simple textures that feature only two shades of color for every part of the model to also simulate shadows like they would also be made within traditional drawn animation. For instance; all skin would be two shades and would not have fine details. Whereas the advanced textures would feature greater details and possibly shading.
- No contour lines against contour lines

Target Group

Based on the period of time known as the Disney Renaissance as mentioned earlier in combination with the age of majority in Denmark it was decided that the target group would be people ages 18 to 35 in order to not need legal permission from parents for participation in testing and this age group would also most likely contain users that had grown up with animated feature films.

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[11] Subsurface Scattering – A mechanism of how light moves in for instance human skin.

Requirement Specification

Based on the analysis and Final Problem Statement a Requirement Specification for the experiment could be developed

- A computer generated 3D model of a humanoid character
- A version of the 3D model with detailed textures and shading of light
- A version of the 3D model with simple cartoon based graphics with contour lines and the individual parts of the model should have 2 colours in order to simulate simple shading as it would be used within traditional cartoons. This version would be referred to as being the hybrid animation.
- A testing scenario testing the effects of the graphical styles conceptualized in the different versions of the 3D model

Based on these requirements the design process could begin, following the specifications and the research attained from the analysis.

Design

The following section will run through the design process of the product needed to test the Final Problem Statement and the process of designing the actual test scenario as it follows the specifications of the Requirement Specifications.

Designing the character

Based on the analysis it was made clear that in order to test the effects of the hybrid animations a character would have to be designed for the purpose. It was decided that the character be male with short hair to make the process of the modeling a simpler process.

Through the analysis it was noted that creating a character with universally aesthetically pleasing traits would be impossible, so it was decided that the character should possess as many of the characteristics that were deemed aesthetically pleasing within humans researched in the analysis and limit the design to what was ideal and necessary for the experiment;

- As researched in the analysis the character would have to be symmetrical, with a slight offset; the eyes should both be the same distance from the nose, but there should be slight alterations of the character to make it not perfectly symmetrical, however these alterations would have to be discrete to not work against the purpose of them.
- Based on the section on the Uncanny Valley it was deemed necessary to choose to either create a photo-realistic humanoid or create a stylized look for the character. Since creating a photo-realistic humanoid would not be possible and would not suit the test any more than a stylized character, it was decided that the character should have a stylized look.

  Figure 12 The character Mr. Incredible from Disney and Pixar's animated movie The Incredibles

  - The character should have exaggerated features; like big eyes, simplified features like the ears and additionally the skin should also be more stylized. For photo-realistic skin the technique called Sub-surface-scattering is used to replicate the way light moves just within the skin of a human, but due to the stylized look such a technique would be disregarded.

    The general shape of the characters head would also

not necessarily have to be completely similar to a real human head. Human characters within traditional hand-drawn animations and 3D computer generated animations often have unique shapes of the head that are mostly quite far from what a real human head looks like, see Figure 12[12]

- The character would not be needed to be designed fully; the head, neck and shoulder area would suffice for the presentation of the character and the graphical concepts. This would also additionally limit any possible affecting factors of the design of the body. This was chosen due to the project focusing on the face and head of the character.

Based on these criteria the character would be designed. Additionally the character should be made into at least 2 different graphical styles to test the effects of the hybrid animation graphical concept as mentioned in the requirement specifications.

Designing and Sketching the Character

Designing the character was done by investigating the character traits of various human characters from some of the popular hand-drawn animated movies and 3D animated movies from the last 40 years. Initially the character would be comprised out of parts inspired from individual characters and would be selected by which parts would fit together. The choice of the individual parts would be discussed to select the most optimal one. Larger versions of the sketches shown in the design can be found in the appendix.

Figure 13 Possible head-shapes

Firstly the shape of the character's head was chosen by sketching up some different possible solutions inspired by simple shapes. The choice of which shape would be featured on the character was made because the design should obviously be human but with exaggerated features; like for instance a very strong jawline. This led to the choice of the 3rd head-shape which had been named Normal as seen on Figure 13. The choice of the head shape that resembled a photo-realistic head the most was made
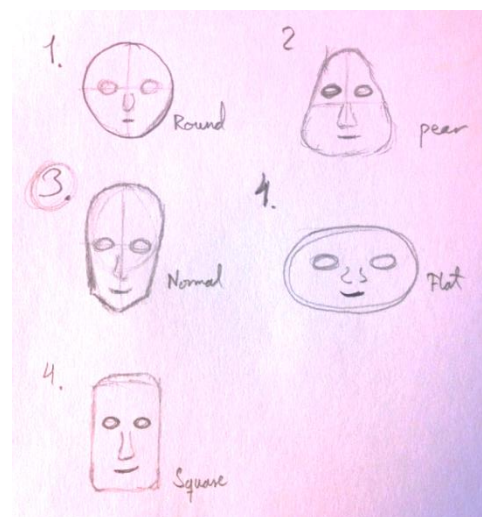
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[12] The Incredibles is an animated movie from 2004, Produced by Pixar Animation Studios and distributed by Walt Disney Pictures

because the combination with the exaggerated features should make the character appear stylized enough to avoid the uncanny valley.

Next came the choice of eyes for the character, possible eye-shapes and –designs were inspired by previous characters from hand-drawn animated cartoons and computer generated 3D animated movies, see Figure 14. The choice came down to eyes 3. 4. and 5. since these looked the most human and would most likely appear on a 3D animated character. The other eyes were not further considered due to their visual style being not human enough. Eyes like the first set would appear comical and could even possibly be distracting from the purpose of the design. Out of the 3 chosen possible solutions the choice fell on option nr 5 because of the exaggerated, yet somewhat realistic look and how big they would appear on
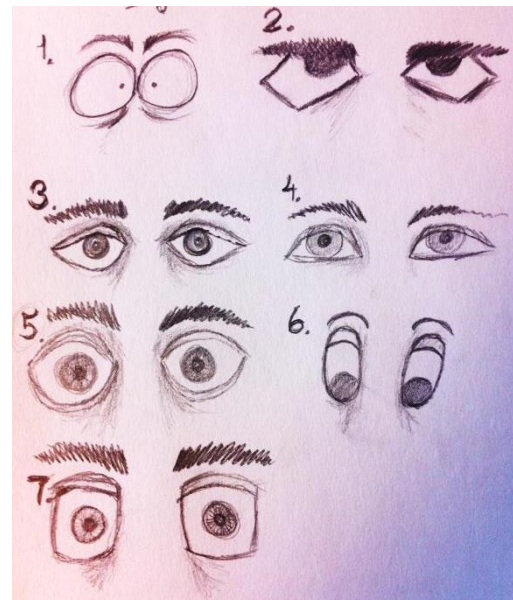

Figure 14 Possible designs of the character's eyes

the character and thus should help the character avoid falling into the Uncanny Valley. It was decided that option 3 and 4 resembled actual human eyes too much and were avoided because of this. The choice came down to avoiding being too photo-realistic but also being too much like a caricature.

Next came the design of the nose of the character. The same method as with the shape of the head and the eyes were used and the 7th design was chosen as seen on Figure 15. The choice was also based on if the shape of the nose would fit together with the chosen set of eyes without
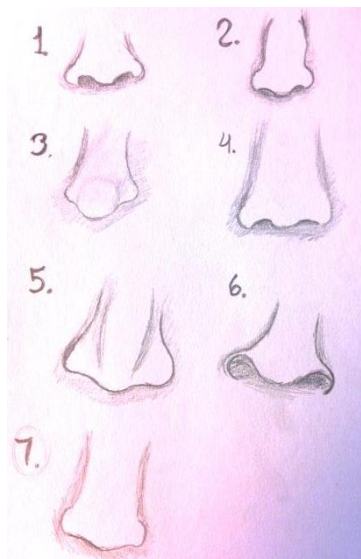

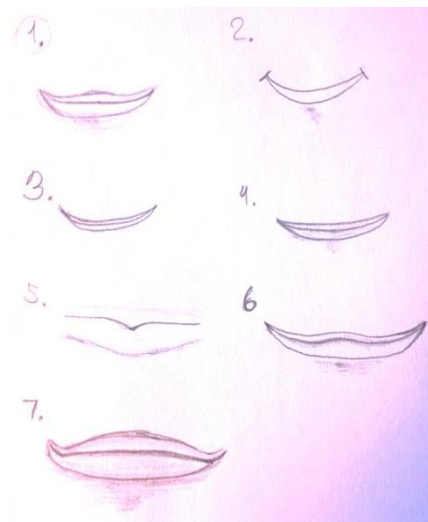**Figure 15 Possible Nose Designs**   **Figure 16 Possible mouth designs**

seeming like individual pieces but more like an actual connected face.

Finally the design of the character's mouth was chosen based on the same criteria as for the other parts of the design as seen on Figure 16 and the 1st design was chosen. The choice of the 1st design was also made due to some of the other mouths appearing too stylized and as such they would not seem natural on the 3D character.

Designing the Test

In order to test and answer the Final Problem Statement it would be needed to create a test scenario. It was decided that in order to research the aesthetic impact of the hybrid animations that a single character should be modeled in Autodesk Maya and then have the different graphical concepts applied in order to have only these graphical concepts to be the varying factors. It was decided that in order to limit bias and changing factors that the only difference between the versions of the character would be the graphical style to see how these would impact the users.

As it was mentioned earlier in the report the focus of the hand-drawn cartoon style was the simple texturing and shading along with the black contour lines and as such it was decided that one version of the character should be made with this simplified cartoon style rendering and with the added contour lines, this was the version earlier named the hybrid animation. Additionally this version should be compared to the character but with normal texturing and rendering as it would be used normally in traditional computer generated 3D animation with more detailed textures, shading, more realistic shadows and without any contour lines. As such these two versions; one with graphical concepts meant to simulate the look of the traditional hand-drawn animated feature films and one with the style of more current computer generated 3D animations would be the main components of the testing, however in order to also test the effect of the contour lines in combination with the more detailed texturing and shading, it was decided that a version of the character also should feature these graphical concepts. It could be argued that an actual hand-drawn animated version of the character should be part of the test, however due to this project researching the effect of hybrid animation on 3D characters the focus should be on the actual computer generated 3D characters with the various graphical concept applied not compared to the animation techniques that should be simulated, based on this it was decided that a hand-drawn animated version of the character would not be part of the test scenario.

In order to design the test scenario, the test would be built based on the Final Problem Statement. It was decided that the most optimal method to test the aesthetic impact of hybrid animations of humanoid characters by employing the theory of memories would be by showing them the character and allow them to rate the character and describe connected emotions to the experience by filling out a questionnaire.

In order to test how the various graphical concepts would affect the test participants it was decided that the test participants should be shown each version of the character and answer a questionnaire in between each one. However in order to limit possible bias based on which character version is shown first the order of the shown characters should be cycled.

It was decided that the most optimal way to find out how the testers perceive the characters would be to have 3 main areas of each questionnaire. Firstly the testers should be asked how aesthetically pleasing they found the character in order to know how they thought the visuals of the character was and secondly they should be asked if they found the character likeable in order to research the testers feelings towards the character that would be based on possible previous experiences, associations even when they later in the test should be asked if the character reminded them of anything or anyone; based on the theory of memories discussed in the analysis even if the testers answer that the character does not remind them of anything or anyone their memories should be affecting them as to how they perceive the character and how they rate how likeable the character is should be reflecting this. It was decided that these two statements should be rated by the tester on a scale from 1 to 7 where 1 would be highly disagree and 7 being highly agree. By using the Likert-scale the questionnaire should produce data that can be analyzed and thus the Final Problem Statement should be able to be answered. The advantage of using the Likert-scale would be that the Likert-scale is optimal for rating attitudes and opinions.

Additionally it was also decided that in order to research which feelings the different versions of the character induced that the third question asked would be about this, asking the test participant to describe with adjectives what the character made them feel.

It was decided that the test participants should also be asked if the character reminded them of anything or anyone and if it did, who or what. This should possibly clarify if the testers have any clear associations with any previous seen characters in movies or cartoons.

As a final question on the individual parts of the questionnaire the testers should be asked where they would imagine the character appearing in order to research if the users find that the character would fit into certain contexts.

On the last part of the questionnaire after filling out the questions about the individual versions of the character they should be asked about some personal details in order to find out who reacts more positively towards the hybrid animation version of the character. As such it was decided that the testers should be asked about age, gender, whether or not they watch cartoons/animated feature films and if they did, how often. Lastly the testers should be asked if they, based solely on the visual aesthetics, prefer classical hand-drawn animated movies or computer generated 3D animated movies. It was decided that they would have to choose between these two choices and not be given the choice of answering that they preferred both equally to force them into choosing their favorite, even if that choice would be affected by their subconscious.

Implementation

Following the design the following section will address how the product was implemented according to the specification given within the design along with any issues that arose during the implementation process.

Based on the choices that had been specified in the design the character was sketched according to the individual parts of the character's face, like eyes, mouth and such. The character was attempted to be given a look that would seem natural within both a computer generated 3D animated movie as well as a traditional hand-drawn animated feature film. The final sketch of the character can be seen in Figure 17

The design process had focused on the individual parts of the character's face but it was first when the character was being sketched that the individual parts were slightly adjusted to fit the character.

Figure 17 The sketched character design Additionally the character was given details like hair and eye-brows to avoid such details to be missing. The character was given a strong chin and big eyebrows to add some masculinity to the character to avoid it being too androgynous. The design of the character was also added a shirt to not appear naked but to avoid any influences it would not be detailed but should just be coloured without any distracting details.

After the sketch of the character had been made and adjusted, the process of modeling the character in Autodesk Maya could begin. The initial shape that the character was based on was a polygon cube with 6 intervals on each axis. The polygon cube was centered on the x-, y- and z-axis and half of the cube was deleted along the x-axis since the modeling would be made as one half of the character and then mirror geometry would be applied to create the character's entire head. However since a requirement from the analysis had been that the character would have to be symmetrical with a slight offset, the character would have to be adjusted after the mirror geometry had been applied in order to make the symmetry of the character not entirely perfect.

After eliminating half of the polygon cube, a rough shape of a human head was made my moving the vertices of the polygon cube, however at all times it was made sure to not move the vertices that would be placed along the symmetry line, along the x-axis so there would be no gaps in the final model.

The initial shape of the character's neck was made by deleting 4 of the faces underneath the model and then extruding the edges into a simple cylinder shape. The process of slightly adjusting the position of the vertices of the character into a more human like head shape kept on

Figure 18 The rough shape of the character's head modeled from a polygon cube

until the shape started resembling the sketch of the character as seen on Figure 18.

After the rough shape of the head had been modeled, additional geometry was added to the facial region of the character. The desired edge-flow was made my adjusting the position of the new vertices that would be in the eye, nose and mouth area of the character. A polygon cylinder was also created and positioned underneath the character so it could later be shaped into a simple upper torso and shoulder area for the character. The polygon cylinder was slightly shaped to match the general shape of a torso and it was turned so it would match up with the geometry of the neck when the individual parts of the character would be combined. A simple eye was made by creating a Nurbs Primitive Sphere to shape the other part of the eye, the inner part of the eye as well as the pupil. The 3 parts of

Figure 19 The character with added geometry for the nose, mouth and eye

the eye was grouped and positioned where the eye would roughly be positioned when finished with the character in order to model the eye-socket around the geometry of the eye as seen on Figure 19.
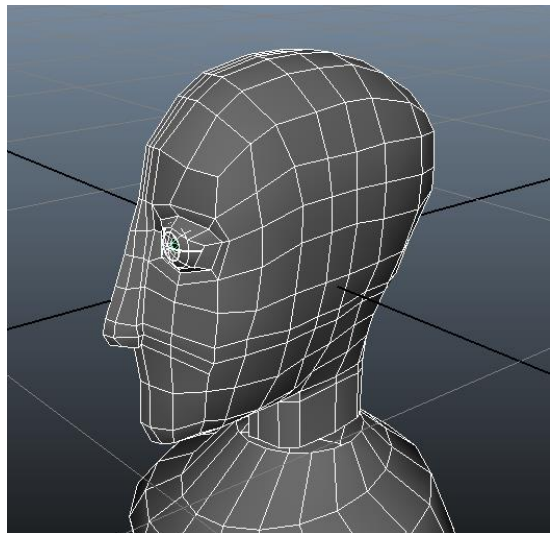
The finer details of the character was modeled along with the mouth and a very simplified human ear and the smooth tool was used to make the character less rough and to add more geometry as seen on Figure 20.

When the shape of the head had been made it was mirrored along the x-axis to form the complete head. Then in order to create the hair and eye-brows the character was duplicated and moved to the side and all faces of the character was removed where the character should not have any hair. The remaining parts of the character were then moved back to the original position of the character and the faces were extruded to form a crude shape of what would later be turned into the hair and eye-brows. The outer vertices of the hair and eye-brow shapes were then pushed into a more smooth shape and pushed into the character to hide any coarse geometry. The top part of the hair was then pulled in individual vertices to form a simple sort of spiky hair. To finish the model Sculpt Geometry tool was used to paint the character in order to add a slight offset on the symmetry of the character as was mentioned earlier in the requirements. The finished character can be seen on Figure 21.

After the character had been modeled the 3 different versions would have to be made. Firstly a colour scheme was chosen that would be used on all three versions of the character as seen on Figure 22. From left to right the colours were for the skin, the hair, the white of the eyes, the shirt and the iris of the eye.
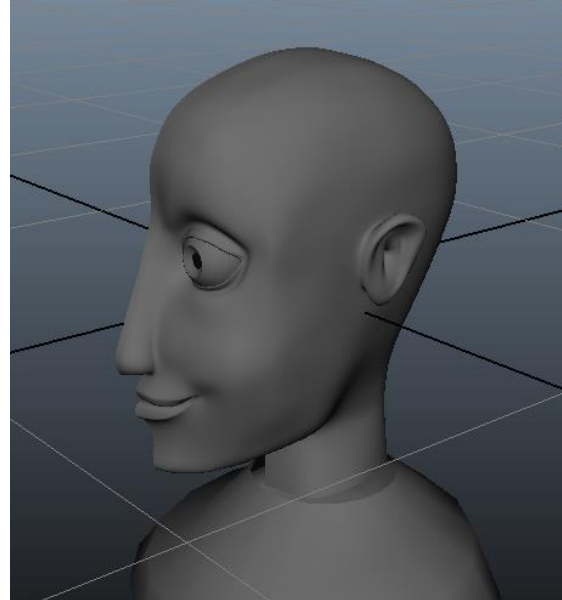

Figure 20 The finished shape of the main part of the character's head
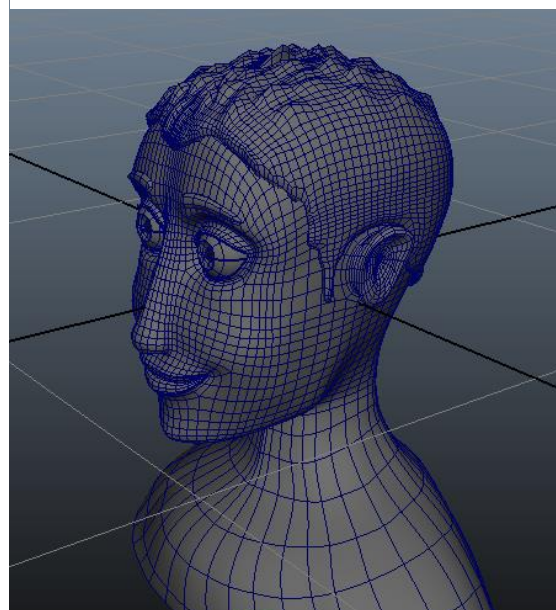
Figure 21 The character after the finer details being included and the smooth tool having been applied

Figure 22 The colour scheme for the character

After choosing the colours the character would be textured with 3 individual characters could be made. First the computer generated 3D version without any cartoon elements were made. The character's UV-Texture was edited within Autodesk Maya and Photoshop to add details and shading while still keeping the design of the character quite simple and without trying to make the character look like a photorealistic version of a human. The texture was painted with details to make it look like the surface of the hair had more details without having to create and render hair on the character. The 3 parts of the eyes of the character was given textures and the outer layer of the eye was made transparent but still made reflective. The iris was made by creating a ramp within Autodesk Maya and various shades of blue were applied to create the iris of the eye.

To create the second version of the character the first character's texture was used, but contour lines were added by selecting all individual parts of the character and using Autodesk Maya's built in function to create contour lines called Assign Outline and then dialing the value of the lines down until they resembled lines as they would appear on a hand-drawn cartoon.

Finally to create the third version of the character Autodesk Maya's built in function Assign Fill Shader and then applying a Light Angle Two Tone to replicate the light conditions on the other characters. All individual parts of the character were selected individually and a slightly darker tone of the colour was selected to be the shadow part of the character to simulate the darker area of the character. The final 3 versions can be seen below on Figure 23. An issue had appeared on the third version of the character since the eye had been based on a Nurbs Primitive Sphere and as such the colouring technique used for the rest of the character was not able to be applied, however due to the requirement of the same character model being used for all 3 versions of the character, it was decided this would be a necessary sacrifice, but it should also be noted in the final discussion.

Figure 23 The three finished versions of the character

After having finished the individual versions of the character a circular shape was created around the character and a camera was created and attached to the shape in order to animate the character so it would turn for the final videos. Using key-frames the camera was rotated 720 degrees around the character over 400 frames. Finally the video format AVI was selected and a high resolution of 1280 times 720 was selected along with some slight compression to limit the video files from becoming too large and the files were rendered and made sure that there were no frames that failed. Because the camera was rotated 720 degrees the individual video files would be able to be looped and would appear to just keep spinning as a continuous video-file.
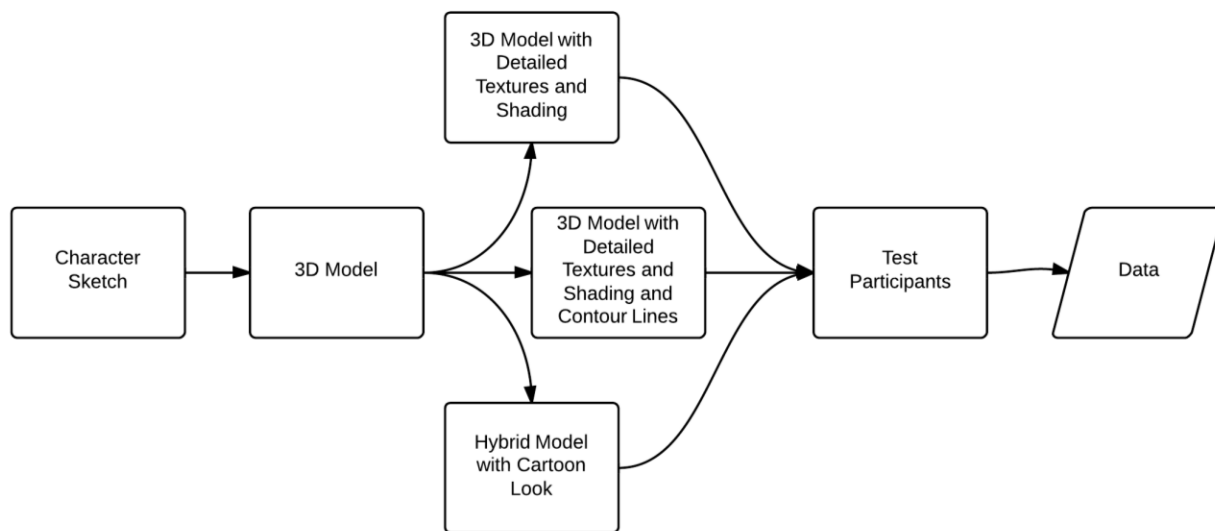

Figure 24 Chart showing the process from the initial character sketch, to the 3 versions of the 3D model and finally resulting in the data from the questionnaire

As it can be seen above on Figure 24 a flow-chart was created to illustrate the process from the initial sketch to the three different versions of the 3D model that would all be showed to the test participants and then finally into the data received from the testers in the form of answers from the questionnaire.

Test

Having finished the implementation it was time to design the test scenario that would yield the data that would ultimately lead to the conclusion. In order to answer the FPS a test scenario was created based upon the research in the analysis, the design choices as well as the solution that was implemented.

Questionnaire

After completing the implementation of the 3 versions of the character it had come to the time of creating the test. Based on the design of the test as mentioned earlier it was decided that due to the nature of the test being; exposure to 3 videos and having to fill out 3 short questionnaires it was decided that creating the questionnaire online would be preferable over having the test participants fill out a questionnaire on paper and as such the questionnaire was made via Google Docs Spreadsheet. By making the questionnaire digital the responses would automatically be entered and the process of entering the answers from a paper-questionnaire into a spread-sheet was eliminated. The final

Based on the design of the test the questions were decided to be as following;

Firstly there would be 3 parts of the questionnaire, one for each version of the character and secondly there would some additional questions on the third and final part of the questionnaire asking into them. Each part of the questionnaire contained the following, the final questionnaire can be found in the appendix;

Based solely on the visual stimuli of the character you have been shown, please rate the following statements on a scale from 1 to 7 where 1 is highly disagree and 7 is highly agree:

1. "I find the character aesthetically pleasing" (rate the visual feedback you are getting from the animation)

1	2	3	4	5	6	7

2. "I find the character likeable"

1	2	3	4	5	6	7

3. Which feelings does the character induce? (Use as many adjectives as you find describes the feelings)

4. Does the character remind you of anything or anyone?

5. If you answered yes above – what or who does the character remind you of?

6. Where would you imagine this character appearing? (a movie, a game, a cartoon etc.)?

On the third part of the questionnaire the following additional questions were also presented;

7. How old are you?

8. Gender?

9. Do you watch cartoons/animated feature films?

10. If yes, please specify how often?

11. Based solely on the visual aesthetics, do you prefer classical hand-drawn animated movies or computer generated 3D animated movies

[   ] Hand-drawn Animations   [   ] 3D Animations

The final part of the questionnaire was intentionally placed at the end of the questionnaire so the questions would not affect the tester and give bias to the answers. Additionally there was also a space made available for the test conductor to fill in which order the videos were presented.

Test Setup

Having created the questionnaire testing could begin. The test was performed over the period of 3 days in total. The test setup was a small cubicle with a laptop and the test conductor standing by at all times in case the testers had any questions. The test setup can be seen on Figure 25.

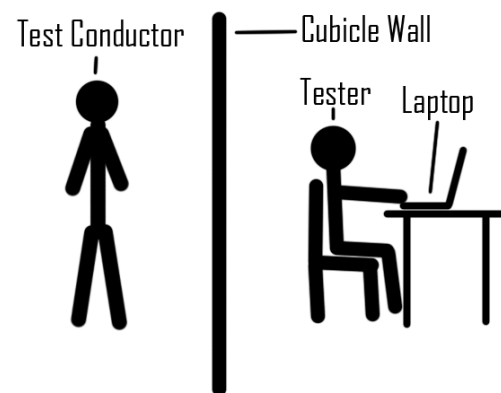Each test participant was brought into the test area and asked to sit down at the table and were then told how the test would be done. The testers were told that they would be presented with 3 versions of a character; they would freely decide how long they would look at the test videos and could return to the test videos if they wanted. After looking at one test video they would have to fill out a questionnaire and when finished return to the videos and press "Next" in order to proceed. The testers were told to contact the

Figure 25 Test Setup

test conductor if they had any questions or were in doubt about anything within the test. The test area was formed by cubicle walls to shield the testers from any other visual input.

To give a better overview of the course of the testing a table was created stating the facts of the test based on how it was done.

Total Days Spent Testing	3
Total Amount of Test Participants	31
Shown Versions of the Character	3
Total Questions on Questionnaire	23
Males Tested	22
Females Tested	9

The decision of using a questionnaire to collect data from the test participants was made due to the advantage of being able to be rather quickly performed as well as given data that could be calculated upon, like Question 1 and 2 on all three questionnaires.

It was also considered to perform interviews of each test participant, however it was decided that it would be sufficient to let the test participants fill out questions so the questionnaire would both supply data to calculate on as well as more feelings-based questions to analyze with for instance a word cloud.

Results

After the testing had finished with a total of 31 test participants the data would be studied in order to form a conclusion. Firstly the data was entered into Microsoft Excel and the order of the input was adjusted so the data could be calculated on. For answers, see the Appendix on the attached CD. Throughout the test results the three versions will be referred to as Version 1, 2 and 3. Version 1 would be the character with detailed textures and advanced shading, Version 2 would be the character with detailed textures, advanced shading and contour lines and finally Version 3 would be the hybrid character with the two colored shading and with contour lines.

The two first questions on each questionnaire would be of the highest interest so they were focused upon. The testers were asked to rate how much they agreed on the statements; I find the character aesthetically pleasing and I find the character likeable. The Likert-scale was used and the values they could enter went from 1 representing that they highly disagreed to 7 representing that they highly agreed and with 4 being the neutral value. The averages of the answers were calculated over the 2 questions rating the 3 versions of the character as can be seen on Table 1.

Table 1 Calculated averages of answers to question 1 and 2 over all 3 versions of the character
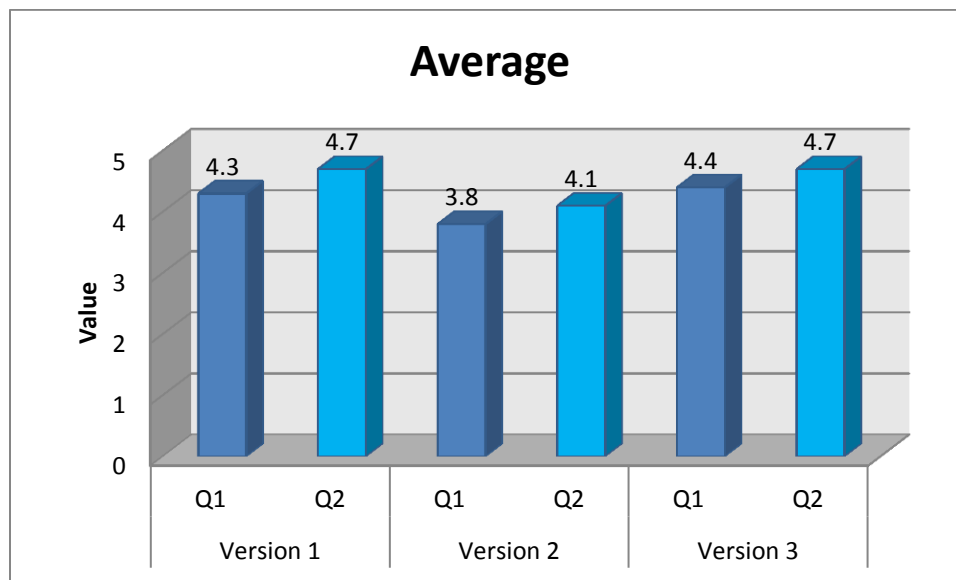

By calculating the average of the values of question 1 and 2 it is apparent that overall Version 1 and 3 of the character were received most positively by the users, however only slightly. Additionally it should also be noted that Question 2 received overall higher scores than Question 1, possibly indicating that the users felt the character seemed more likeable than aesthetically pleasing. Comparing these values

with the groups based on their stated preference of either Hand-drawn animations or Computer Generated 3D animations should give further indications if this should be assumed that the users have subconsciously associated the characters with previous characters and thus giving the higher likeability rating over the aesthetics.

Based on the question regarding the users' preference of the aesthetic style of either Computer Generated 3D animations or Hand-drawn animations the data was sorted and new averages for the individual groups were calculated as seen on Table 2.

Table 2 The averages based on the 2 groups of testers based on their preferred style of animations
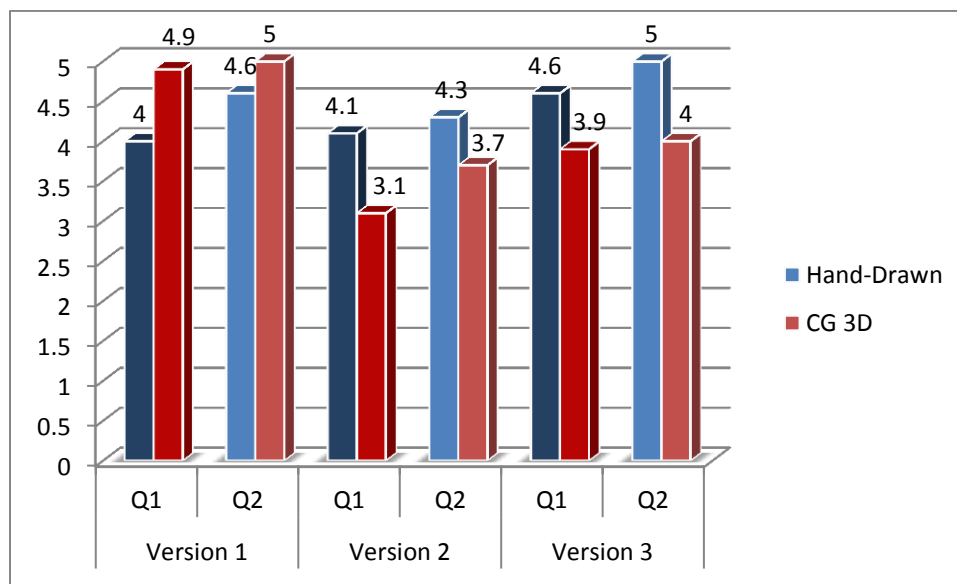
As it can be seen above the preference of which style the users preferred is shown very clearly in Question 1. The users that stated that they preferred the graphical style of Computer Generated 3D animations gave the first version of the character the highest scores as well as it can be seen that the users that preferred the Hand-drawn Animations rated the third version of the character the highest. The interesting detail with this piece of information is that the users rated the hybrid character the highest even though the graphical concepts that were applied to it were not actually the same as used in hand-drawn animations, but were only supposed to simulate them and as such they were successful. It can also be seen that Question 2 was on average rated the highest within the individual groups that preferred the respective graphical styles of the models, except for the second Version of the character that received significantly lower scores in both Question 1 and 2 for the group that preferred Computer Generated 3D. The group that preferred hand-drawn animations gave most versions of the character a

higher rating than the users who preferred computer generated 3D, except for the first version of the character that received significantly higher scores compared to the two other versions of the character.

Next the data was sorted based on the question of whether the individual characters reminded the testers of anything or anyone and the average values were calculated as can be seen below on Table 3.

Table 3 Groupings based on whether or not the individual versions of the character reminded the testers of anything or anyone
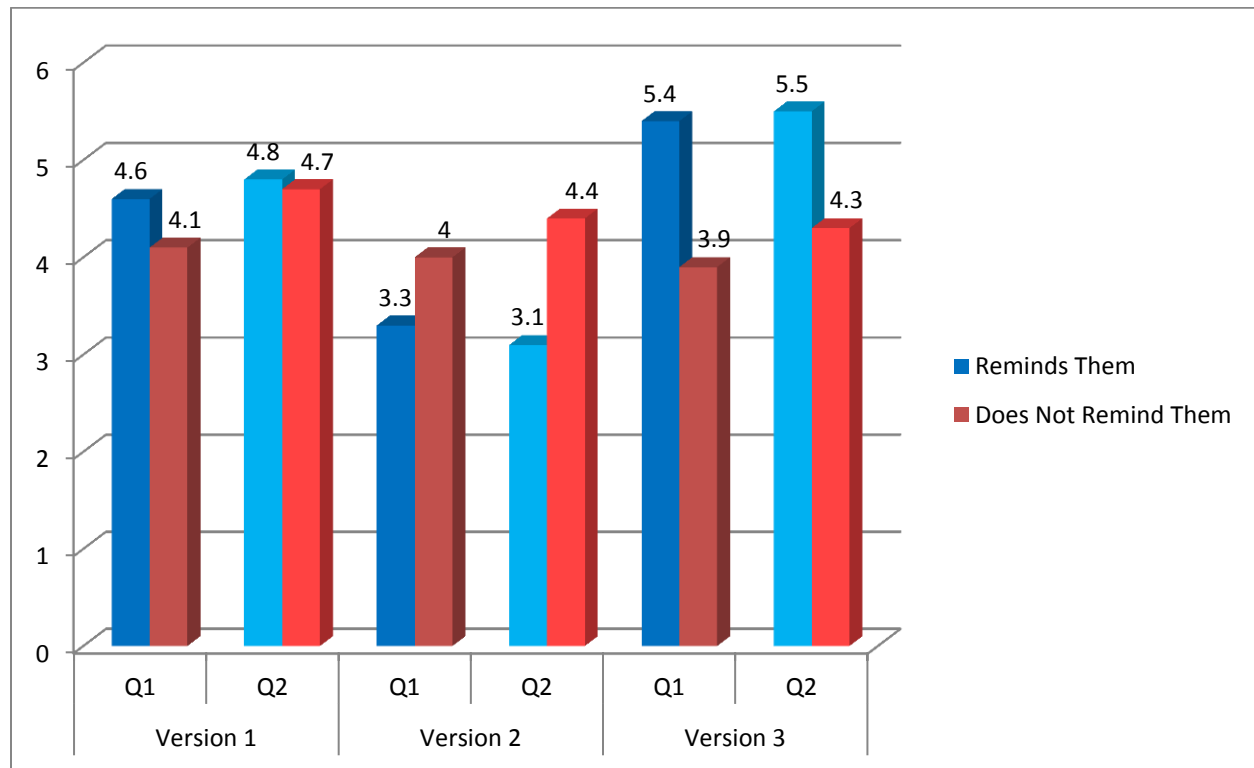
For version 1 and 2 the differences are not that significant, however on version 3 the grouping of testers that felt the character reminded them of something or someone scored significantly higher on both Question 1 and 2. As mentioned earlier a directly higher score in this grouping for version 3 could possibly indicate that in fact the hybrid animations were successful in making the testers perceive the character as more likeable and aesthetically pleasing by utilizing the theory of memories. The tendency of preference for the third version of the character in the grouping of testers where the character reminded them of something or someone had such a higher rating that it is deemed successful of utilizing the theory of memories to the advantage of increasing the positive impact of both likeability as well as being aesthetically pleasing.

In order to see if the results were affected by the test participants' gender the data was sorted by gender and the averages were calculated again as seen on Table 4.

Table 4 Average sorted based on test participants' gender
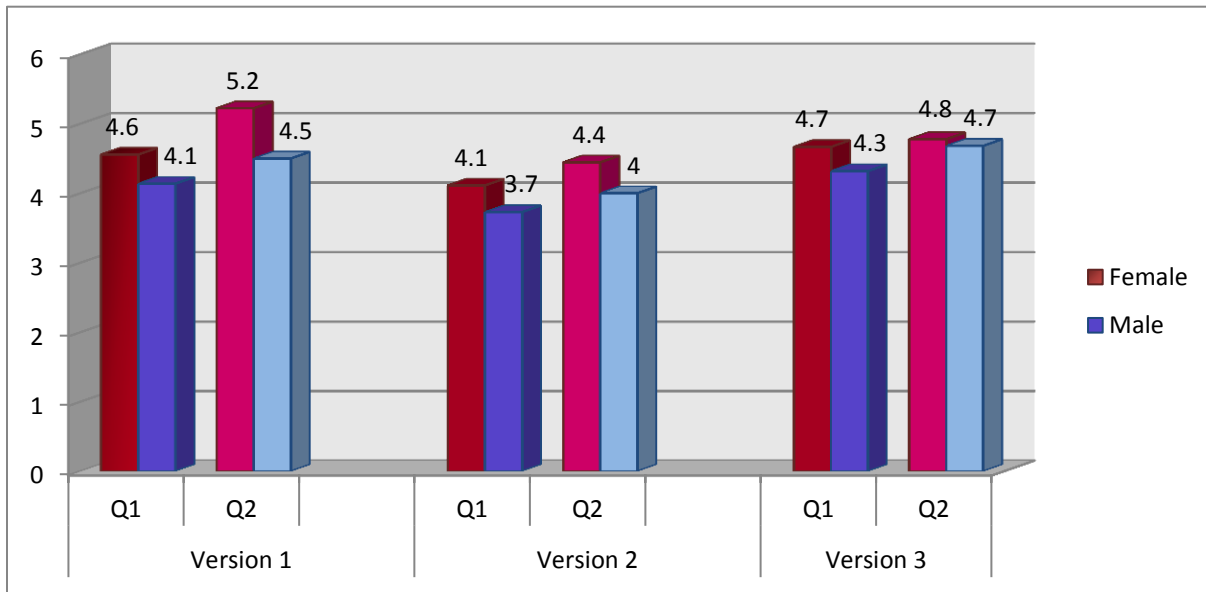
As it can be seen above the female test participants rated on average all the character versions slightly higher than the male test participants; however since the difference between the genders' answers are so minute and the only significant difference can be seen for version 1 of the character with question 2 the correlation between the answers based on gender will be considered as being not significant. Had the test been on a larger scale such a difference of the averages would have been more interesting, but out of a total of 31 test participants these differences will be considered as insignificant.

The third question in the questionnaire was asked to see which feelings the character versions gave the test participants, however due to the relative small amount of testers the users answered very differently; however word clouds could still be created depicting the most frequent words the testers used to describe their feelings. As seen below are 3 word clouds created from their answers, the larger a word is, the more test participants answered it.

Table 5 Three word clouds depicting the test participants' answers to Question 3 in the questionnaires

As it can be seen over the three word clouds, the word happy is the dominating adjective used to describe the feeling the testers had being exposed to the character versions, however as it can be seen many negative adjectives have also been used like; creepy, uncomfortable and unease, so even though the general outlook on the character was positive, negative emotions were also apparent for many of the testers.

Even though a word cloud is typically not considered a scientific method, it was applicable here because of how easily visually it depicts the most given answers and as such it was deemed a useful tool in analyzing the data from the questionnaires.

It should however be noted that several testers commented after the test on version 1 and 2 of the character and said that the smile of the character gave them uncomfortable associations and there seemed to be something wrong with it. Unfortunately this would seem that character version 1 and 2 had fallen directly into the uncanny valley as mentioned earlier in the report. Many of these users commented that the mouth of the character looked much better on the third version of the character since some of the details could not be seen because of the cartoon inspired graphics; these notes should be taken into account when concluding upon the test.

Discussion

As it can be seen in the results, the overall scores of version 1 and 3 of the character were the highest and version 2 of the character received the lowest scores and comments in general. A possible reason for this outcome could be argued to be based on the concept of the graphics; version 1 and 3 both contain the primary graphic concepts that would normally be seen together e.g. the simplified shading on version 3 in combination with the contour lines, compared to version 2 that combines the contour lines with the shading that would normally be used in traditional 3D graphics. It is possible based on the theory of memories that because previous memories affect how new experiences are perceived that because version 2 of the character does not remind the testers of a pre-existing concept as much as version 1 and 3 that the testers rated it lower because the lack of familiarity.

Based on the results it can be argued that there in fact is a positive connection with the use of hybrid animations. Based on the theory of memories it can be argued that the users associate the third version of the character with previous experiences due to the hybrid graphics, however based on the results it should also be noted that the contour lines are not enough to create a visual style for the character that will affect the users positively. Based on the popularity of the first and third version it can be argued that people that prefer the classical hand-drawn animations will always prefer the visual style even when it is simulated as these hybrid characters, bringing together Computer Generated 3D models with the style of the classical hand-drawn animations.

The issue of the eye of the character being identical on all three versions was not mentioned by any testers and as such it cannot be seen if it affected the testing in a negative way. For any further testing the issue however would have to be resolved.

Based on both written and spoken comments on the first and second character version the results could have been affected by the character's mouth bringing the whole of the character into the Uncanny Valley despite the attempts of avoiding this, and as such could have affected the results, however since it was not all test participants that mentioned this it could also be the opinion of some of the test participants instead of a general opinion. Since the word happy dominated the word clouds for all three versions of the character it can be assumed that the majority of the testers did in fact find even the first and second version of the character not uncanny enough to mention it. For a more optimal testing scenario it could be argued that in order to better research the impact of the hybrid animations that more 3D characters should be used instead of only one. The choice of using only a single character was

done due to how extensive the process of implementing a single one was and it was more suitable for the time-frame of the project.

A possible way of improving the test scenario could also be made by sampling a greater selection of test participants. Out of the 31 test participants the age range was from 18 to 28, however it could have been interesting to see how the versions of the character would have been received by testers that did not fall within the age range of the target group because of the potential scenario of very young test participants not having been as exposed to the older classical hand-drawn animated feature films and potentially much older test participants not having been as exposed to computer generated 3D films compared to the target group. The time frame given for the project did not allow extensive testing and as such the optimal target group was decided to be the chosen one, but it could have been interesting to see how the test had been affected by including test participants from out of the target group.

A potential fault that was made within the test was regarding the third question on each of the 3 questionnaires. The testers were asked about which feelings the character induced and based on the answers it seems as if the testers either assumed that they were supposed to describe the character or which feelings they themselves experienced and as it was supposed to be the latter it can be seen as a possible error. It could possibly have given better answers for that question if the phrasing of the question had been more focused on that it was the feelings the character gave the testers that they were supposed to have answered. However due to the answers given it can still be seen that most of the testers did understand the question and gave answers to the question as it was intended.

Another potential error was based on the implementation; the lighting in version 1 and 2 were commented by some testers to being very dark compared to version 3 of the character. The lighting was decided to be the same for all three versions of the character; however the character appears much lighter on version 3 because the shading was made with 2 shades instead of the more complicated shading as used on version 1 and 2. The lighting in version 1 and 2 could potentially have been increased in order to compensate for the differences in the graphical styles, however this error was discovered at too late a stage to correct it and it would have changed the test entirely and would have had to be researched in order to implement such a compensation without affecting the outcome of the test negatively.

Since the testing in this report is based on a theory created by combining pre-existing theories and science there is also a certain degree of possibility that the testers answered without being affected by

their subconscious. It was mostly assumed that based on the discussion of how humans relate and the human brain categorizes that the testers would be affected by their subconscious, however this is still a theory even though it did show a tendency of actually being affected by their previous memories.

Conclusion

Based on the results and the discussion it is concluded that the third version, the hybrid character did in fact have a positive impact on both the aesthetic value as well as for likeability for users who preferred the graphical style of the classical hand-drawn animations by drawing associations to previous experiences of cartoons. However due to the uncertainty of the users preferring the hybrid style due to their upbringing or just due to general taste it leaves the theory plausible, not confirmed. Based on the theory of memories all taste is affected by previous memories, so the users that preferred the third version of the character would most likely have had their aesthetic judgment affected by previous experienced cartoons.

The technology researched within this report could possibly be a benefit within the production of games or movies. If by applying the hybrid graphical concepts in for instance a video-game production, the graphical appeal could possibly shift and appeal more to certain age groups by having graphical styles that could be considered nostalgic or highly stylized. Since the actual production of the simplified shading and adding the contour lines were comparatively simple compared to the more detailed 3D graphical style, it could also speed up the production of implementation for the graphic department if such a graphical style could be an acceptable solution.

In conclusion, the hybrid style simulating classical hand-drawn animations used on a computer generated 3D humanoid character did show a tendency of impacting aesthetic value and likeability because of the theory of memories; however more extensive testing would be needed to confirm it, but the promising results suggests that it could potentially be a valid theory.

Future Development

Had the time frame of this project been different it would have been interesting to perform the same test, however with different characters. Some testers mentioned that they found the character uncanny even though measures were taken to specifically avoid this. It could possibly have been lack of experience of modeling humans that led to the character being received this way by some test participants but if the study had been redone with several different characters, each with the 3 versions that were tested, it could possibly have given other results.

It was purposely decided to create the 3 versions of the character with a white background to avoid any bias from the context, however it could have been interesting to see if the way the testers perceived the characters would also have been influenced by changing the context of what they appeared in, in this case the context being the background. Just as it is mentioned in the pre-analysis that cartoons created with the cel animation technique often had very detailed painted backgrounds it would have been interesting to see if drawn or more photo-realistic backgrounds would have affected the results.

In the case of creating more characters, a test scenario where pre-existing characters were re-created as 3D models but then shown as the opposite of the style that they normally appear in would also have been an interesting scenario. For instance characters from the computer generated 3D animated movie Tangled[13] presented with the hybrid animation graphic style or characters from the hand-drawn Aladdin[14] presented with the newer 3D computer generated graphics with more detailed textures and shading. However this would be a much larger scale project, but it would be interesting nonetheless.

Further research in areas of different cultural styles of animations and cartoons could also have been a point of interest and could be a potential future improvement. Researching how colours and lighting affect the design process of characters, for instance some cartoons use colours to theme alliances within the story-lines; for instance Disney's Aladdin presented good characters in blue and light colours, but evil characters primarily in red and dark colours. Colour choices could also be researched to see if different cultures react differently to colours and to see how this would have affected the character design process. Further study of character design could also possibly hold more advantages in creating a character that would be perceived as being likeable and aesthetically pleasing, research in cultural and ethnological effects within character designs and perception would also have been interesting. A

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[13] Tangled – Released in 2010, produced by Walt Disney Animation Studios and distributed by Walt Disney Pictures.
[14] Aladdin – Released in 1992, produced by Walt Disney Feature Animation and released by Walt Disney Pictures.

possible different testing scenario could also have been by presenting the same test as performed for this project, but without colours. Having the character appear only in black and white and shades of gray it could potentially have affected the outcome.

A possible alternative testing scenario could also have been made by having the testers rate several characters and then being introduced to several different versions of the character the tester rated the most positively to avoid the tester feeling negatively towards the character to begin with.

If the scenario was possible it could also hold interest to create a test scenario where the testers would have to rate several characters all from different cultural styles, for instance Western designed cartoon characters or Japanese styled cartoon characters.

An additional alternative design of the character is featured at the end of the appendix. It was designed much like the character used in the project, but with a more stylized look to avoid the uncanny valley.

Bibliography

Brown, L. (1993). *The New Shorter Oxford English Dictionary, Vol. 2 N-Z, 1993 edition.* Oxford: Clarendon Press.

Dutton, D. (2003). Aesthetics and Evolutionary Psychology. In D. Dutton, *The Oxford Handbook for Aesthetics.* New York: Oxford University Press.

Dutton, D. (2005). *The Oxford Handbook of Aesthetics - ISBN: 0-19-825025-8.* New York: Oxford University Press.

Greydanus, S. D. (n.d.). *Quo Vadis Disney? Notes on the End of the Disney Renaissance, circa 2001*. Retrieved April 1, 2013, from Decent Films Guide: http://www.decentfilms.com/articles/quovadisdisney

Hachigian, J. L. (n.d.). *Celshader.com FAQ.* Retrieved April 1, 2013, from Celshader.com: http://www.celshader.com/FAQ.html

Huth, A. G., Nishimoto, S., Vu, A. T., & Gallant, J. L. (2012). *Semantic representation in the human brain.* Berkeley: University of California.

Jacobsen, T. (2010). Beauty and the brain: culture, history and individual. *Journal of Anatomy*, 184-191.

Laybourne, K. (1998). *The Animation Book : A Complete Guide to Animated Filmmaking—From Flip-Books to Sound Cartoons to 3-D Animation - ISBN: 051-788602-2.* New York, U.S.A.: Three Rivers Press.

Levy, S. (2004, November 21). *Why Tom Hanks is Less Than Human*. Retrieved April 1, 2013, from The Daily Beast: http://www.thedailybeast.com/newsweek/2004/11/21/why-tom-hanks-is-less-than-human.html

Nethery, D. (n.d.). *Notes Discussion , Notes, Links for Online Animation Students*. Retrieved April 1, 2013, from Academy of Art Animation: http://hand-drawn-animation.blogspot.dk/

Oxford, D. (n.d.). *Oxford Dictionaries*. Retrieved April 1, 2013, from Oxford Dictionaries - Aesthetics: http://oxforddictionaries.com/definition/american_english/aesthetic

Roos, D. (n.d.). *How Computer Animation Works*. Retrieved April 1, 2013, from HowStuffWorks: http://entertainment.howstuffworks.com/computer-animation.htm

Seyama, J., & Nagayama, R. S. (2007). *The Uncanny Valley: Effect of Realism on the Impression of Artificial Human Faces.* Tokyo: University of Tokyo.

Shacter, D. L., Gilbert, D. T., & Wegner, D. M. (2011). *Introducing Psychology - ISBN-13: 978-1-4292-1821-4.* New York, U.S.A.: Worth Publishers.

Simpson, A. (n.d.). *John K's Guide to Surviving the End of Television*. Retrieved April 1, 2013, from Cold Hard Flash: http://www.coldhardflash.com/2007/04/john-ks-guide-to-surviving-end-of.html

Wolfe, J. M., Kluender, K. R., Levi, D. M., Bartoshuk, L. M., Herz, R. S., Klatzky, R. L., et al. (2009). *Sensation and Perception (2nd ed.) - ISBN: 0878939539.* Massachusetts, U.S.A: Sinauer Associates Inc.

Zangwill, N. (2003, February 28). *Aesthetic Judgement*. Retrieved April 1, 2013, from Stanford Encyclopedia of Philosophy: http://plato.stanford.edu/entries/aesthetic-judgment/

Table of Figures and Tables

Appendix

Questionnaire

The questionnaire as it was presented to the testers is shown below:

1st Shown Character

Based solely on the visual stimuli of the character you have been shown, please rate the following statements on a scale from 1 to 7 where 1 is highly disagree and 7 is highly agree:

1. "I find the character aesthetically pleasing" (rate the visual feedback you are getting from the animation)

1	2	3	4	5	6	7

2. "I find the character likeable"

1	2	3	4	5	6	7

3. Which feelings does the character induce? (Use as many adjectives as you find describes the feelings)

_____
_____
_____

4. Does the character remind you of anything or anyone? _____
5. If you answered yes above – what or who does the character remind you of?

_____

6. Where would you imagine this character appearing? (a movie, a game, a cartoon etc.)?

_____

2ⁿᵈ Shown Character

Based solely on the visual stimuli of the character you have been shown, please rate the following statements on a scale from 1 to 7 where 1 is highly disagree and 7 is highly agree:

1. "I find the character aesthetically pleasing" (rate the visual feedback you are getting from the animation)

1	2	3	4	5	6	7

2. "I find the character likeable"

1	2	3	4	5	6	7

3. Which feelings does the character induce? (Use as many adjectives as you find describes the feelings)

_____
_____
_____

4. Does the character remind you of anything or anyone? _____
5. If you answered yes above – what or who does the character remind you of?

_____

6. Where would you imagine this character appearing? (a movie, a game, a cartoon etc.)?

_____

Niels Henrik Breiner Sørensen   Spring 2013
Aalborg University Copenhagen   Master Thesis

3rd Shown Character

Based solely on the visual stimuli of the character you have been shown, please rate the following statements on a scale from 1 to 7 where 1 is highly disagree and 7 is highly agree:

1. "I find the character aesthetically pleasing" (rate the visual feedback you are getting from the animation)

1	2	3	4	5	6	7

2. "I find the character likeable"

1	2	3	4	5	6	7

3. Which feelings does the character induce? (Use as many adjectives as you find describes the feelings)

_____
_____
_____

4. Does the character remind you of anything or anyone? _____
5. If you answered yes above – what or who does the character remind you of?

_____

6. Where would you imagine this character appearing? (a movie, a game, a cartoon etc.)?

_____

7. How old are you? _____
8. Gender? _____
9. Do you watch cartoons/animated feature films? _____
10. If yes, please specify how often? _____
11. Based solely on the visual aesthetics, do you prefer classical hand-drawn animated movies or computer generated 3D animated movies
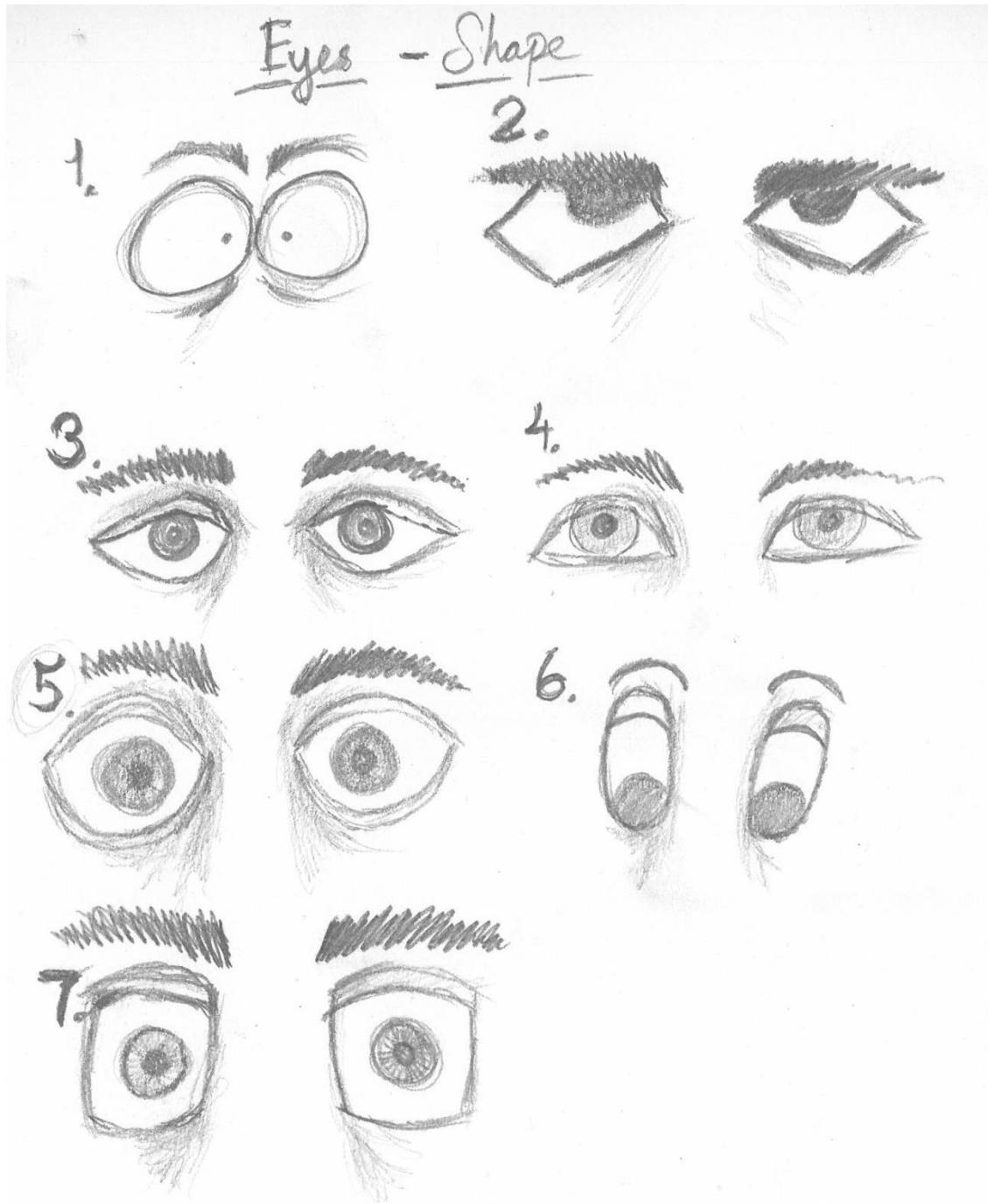   [   ] Hand-drawn Animations   [   ] 3D Animations
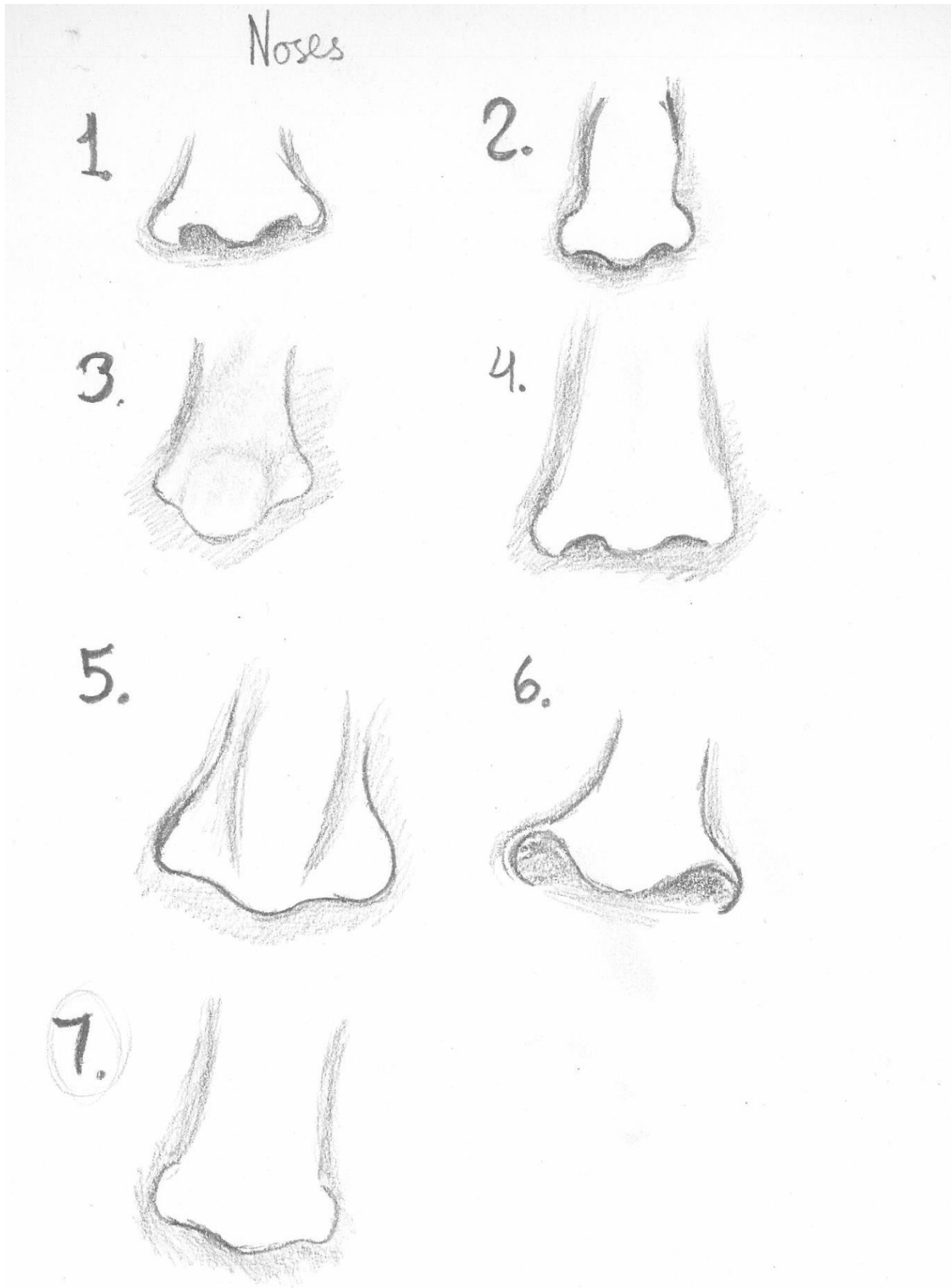
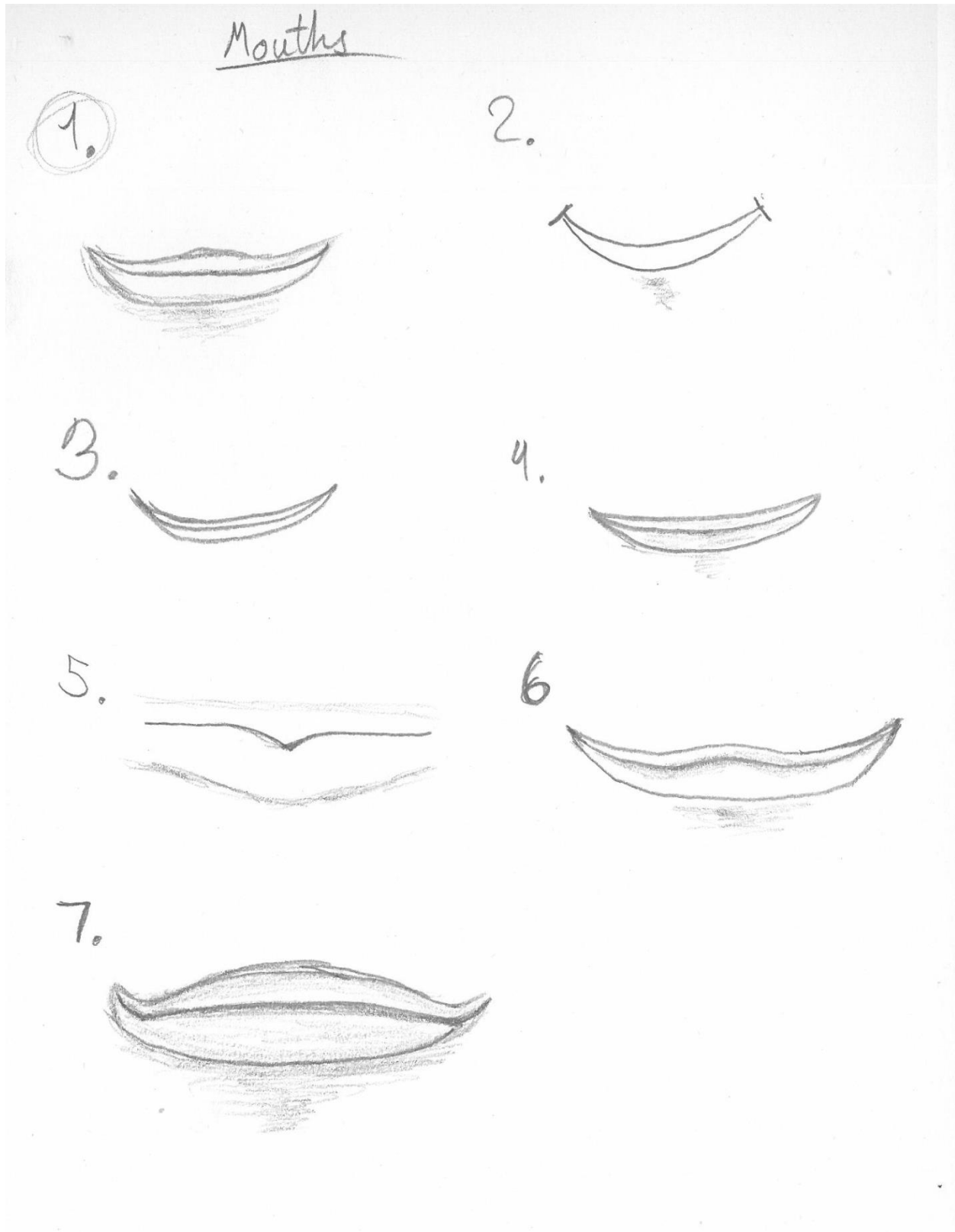(The following will be filled in by the test conductor)

Order___

Sketches

The following will be the various design sketches that were used throughout the project and one that was not used, but was created as a more stylized example of the character.
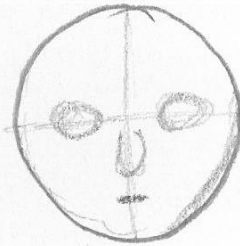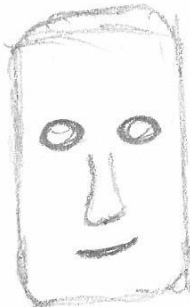
Noses

1.

2.

3.

4.

5.

6.

7.

Mouths
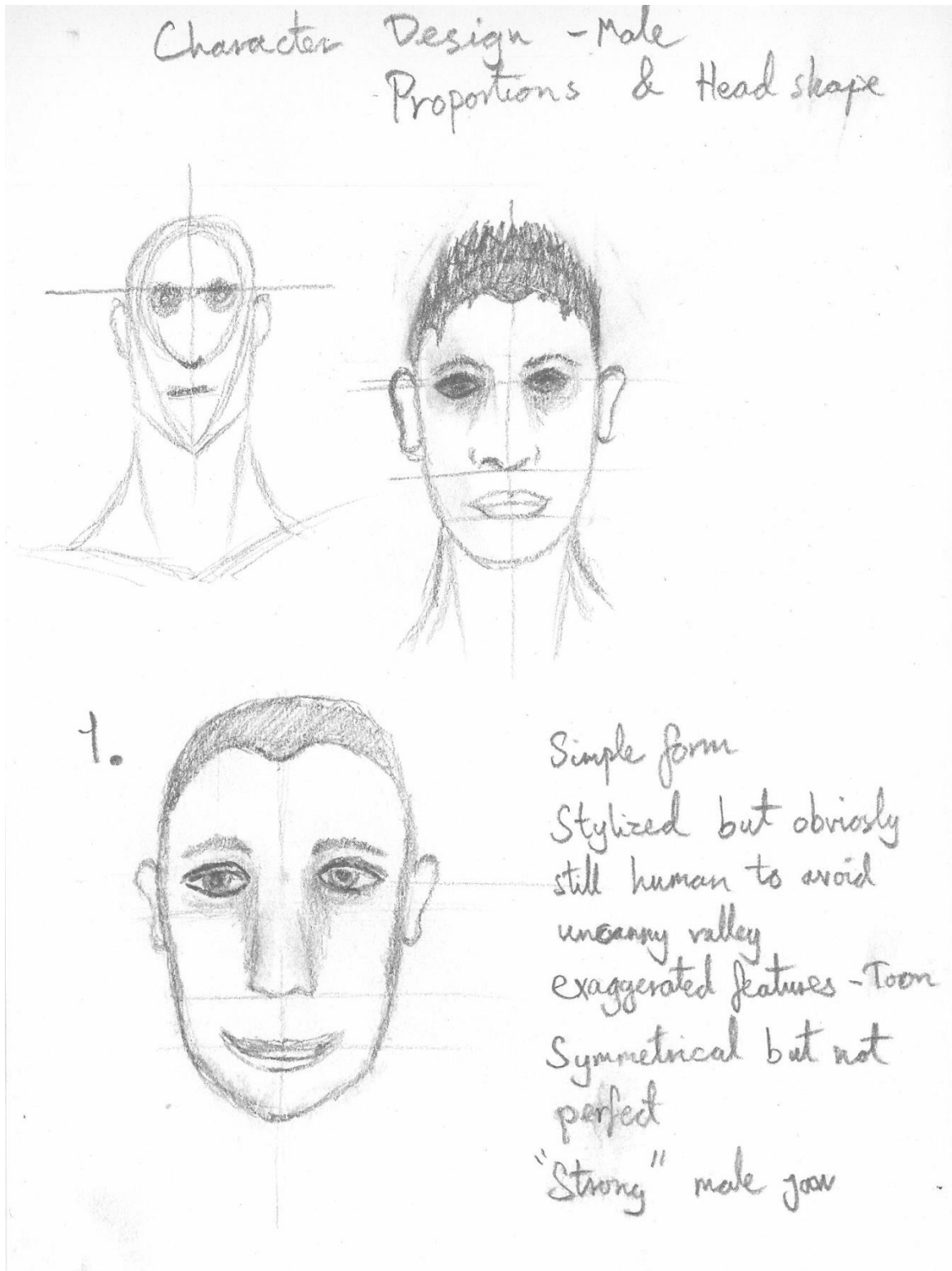
Head Shape

1. Round

2. pear

3. Normal

4. Flat

4. Square