

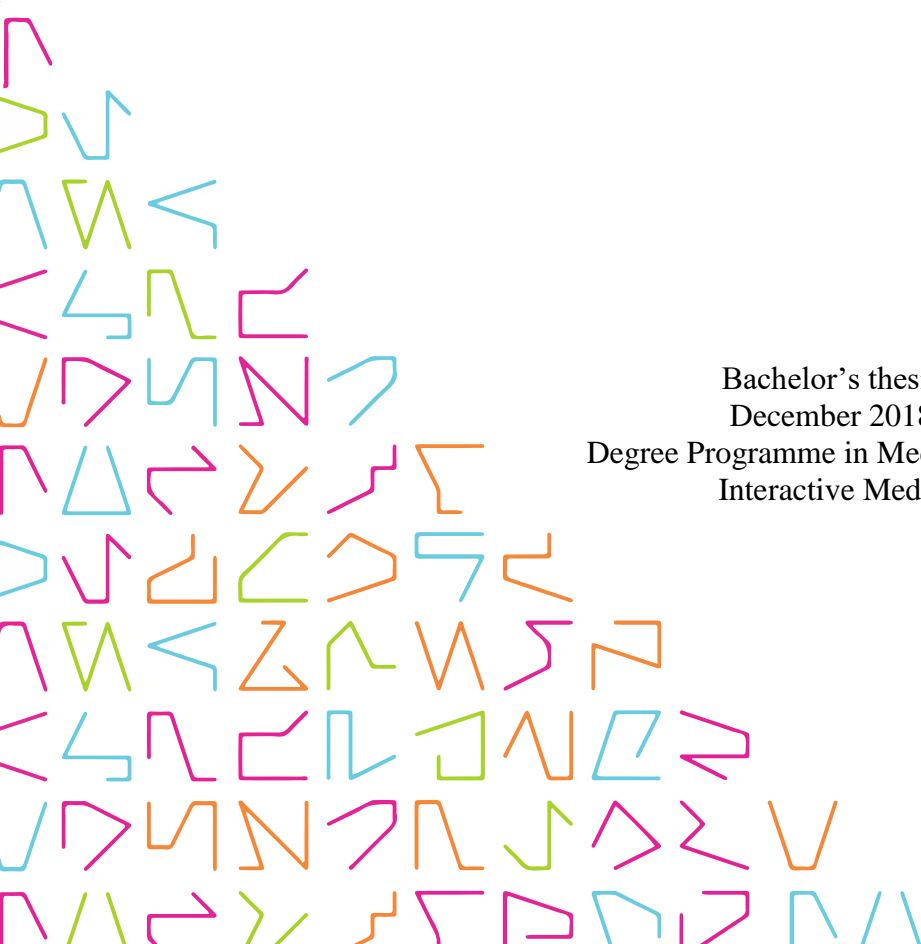


TAMPEREEN  
AMMATTIKORKEAKOULU

# READABILITY AND STAGING OF CARTOON CHARACTERS IN 2D AND 3D

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Bachelor's thesis  
December 2018  
Degree Programme in Media and Arts  
Interactive Media



## **ABSTRACT**

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2D cartoons have always been a medium that has amazed its viewers with characterful visual simplicity and exaggeration that exceeds the boundaries of realism. They are also the medium's greatest strengths against 3D animations that have not been able to compete with the flexibility and liveliness of 2D animations until recently. Therefore the purpose of this thesis was to find means for maintaining the original playfulness and readability of Betty Boop, a classic cartoon character from the 1930s, when her 2D character design is recreated in 3D environment.

The research was started by defining the areas of cartoon character design that can benefit from readability improvements, because readability plays an important role almost in every creative medium from graphic design to literature. Visual elements and narrative become more accessible and understandable to their audience if they are presented with appropriate clarity. Recurring practices were examined in the following series: Betty Boop, Fingerpori, One Piece, Naruto, Dragon Ball Z, Boku no Hero Academia, and The Adventures of Tintin.

The results indicated that cartoon characters' seemingly scarce details can be harnessed to provide as much information about their forms and purpose as realistic depictions of characters can. Cartoons even boost readability and staging further by using symbolic cues and abstract elements. Cartoony simplification of specific elements also saved the 3D Betty Boop, because abstraction helped it to draw attention away from technical limitations. The outcome proved that the two mediums work well when they complement each other.

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Key words: cartoon character, readability, staging, 2D art, 3D model

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## ABBREVIATIONS AND TERMS

3D mesh	Collection of faces/polygons, edges and vertices that define the shape of 3D object. Often shortened to “mesh”.
3D space	The space where 3D objects exist in a 3D software. The object and space can be examined and viewed through the 3D software’s viewports.
Anime	Japanese animated cartoon. Refers to their visual style in some cases.
Autodesk Maya	3D modelling and animation software by Autodesk. Often shortened to “Maya”.
Black and white cartoon	Any cartoon, manga or anime that only uses black and white or shades of gray for drawings and shading
Blend shapes	Function that stores alternative versions of 3D meshes in Autodesk Maya. User can switch between the original version and the alternative versions by using a slider tool that can gradually turn one version into another.
Caricature	Portrait or illustration that has been given exaggerated features, often in humoristic or mocking manner
Cartoonist	Artist that creates or draws cartoons
Cel shading	3D rendering style that imitates the stylized look of 2D cartoons
Child object	Object that has been linked to a parent object and/or its properties
Manga	Japanese comic. Refers to their visual style in some cases.
Mesh/skin weight	Value that represents the strength of deformations when a rig’s bone is moved. Zero value means a specific bone does not create deformations. High value indicates a bone’s movements have highly visible effects on the mesh
Parent object	Object that has one or more child objects that are linked to it or its properties
Render	Action or process that turns a 3D scene into a 2D image in 3D modelling or rendering software

Rig	Set of digital “bones” that can be moved and altered to animate 3D objects or their parts in 3D space. Often represents a skeleton in character art.
Rigging	The process of creating a rig for a 3D model and attaching the latter partially or wholly to individual bones of the rig
Texture	2D image file that can be projected onto 3D objects for decorative purposes
Weight painting	Action that increases or decreases mesh weight values in desired areas

## 1 INTRODUCTION

Cartoons are a form of visual storytelling that have often been seen as a medium of cheap gags and childish visual style. They appear as comics, illustrations and animations that tell stories from various genres: it can be a stylized caricature portrait that makes fun of a political figure by representing that person in an absurd manner, a comic strip in a newspaper that illustrates the latest shenanigans of the certain lasagne-loving feline, or a Japanese animated movie with a spiky-haired ninja protagonist that can turn into a demon fox. Despite the different audiences that they cater to, all cartoons have a common key feature and it is simplification of visual reality. But if they employ simplified versions of something that already exists in the real world, do they also lose or twist some of the visual information that they should be giving to the audience?

Look at Mickey Mouse for example and then imagine a real mouse in your head. The former seems to be a highly stylized version of the latter, but its style still tells you that the character is a sort of mouse, regardless of the change of details and representation that makes him resemble a little boy. If you read a passage from a fairy tale book that contains animal characters, on the other hand, you would probably create appearances for the creatures in your imagination based on the author's descriptions. According to cartoonist Will Eisner (2008, 149), both mediums in this case work as a language of their own to tell something about the characters that the artists had created. The fairy tale, as a work of literature, relies on words and metaphors that invokes the reader's imagination, while a cartoon works similarly with images that are sometimes accompanied by sounds and limited amounts of text.

Readability of cartoon art, and especially the simplified, yet lively characters presented by a single illustration or a series of them, are therefore worthy of closer inspection. As cartoonist Scott McCloud states (2006, 29), delivering the creator's intent properly to the audience is the biggest challenge that cartoons face, because people lose interest to images that do not communicate well. Cartoonists' practices in the following cartoons and comics were examined: Adventures of Tintin, Naruto, Fingerpori, Dragon Ball Z, One Piece, My Hero Academia, and Betty Boop.

Cartoons were a 2D medium for a long time, but the advent of 3D graphics created a new playground for them. Possibilities provided by the modern image rendering technique sounded like natural evolution for cartoons that had traditionally been drawn by hand, but how well have the abstract qualities of cartoon characters transferred to the 3D environment? Because of the limitations of 3D modelling softwares, some elements cannot be created as easily as they were with pen and paper, whose only limitation usually was the artist's own imagination and drawing skill. A good example of this would be the ears of Mickey Mouse, that seem to retain their spherical silhouette in every angle. Wild hair styles of Japanese anime characters also exemplify this kind of disregard for realistic depiction of perspective and anatomy. Transferring these abstract qualities from a 2D character concept to a 3D model therefore became the practical part of the thesis. The classic cartoon character Betty Boop from the 1930s was chosen for the adaptation, because her character design and low amount of modern 3D depictions presented interesting challenges for retaining the original feel and readability of visual elements.



## 2 READABILITY

Readability, despite its name, can be associated with legibility of text and visual elements in printed media, web design and even in illustrations. Clarity of content and how easily it can be understood and perceived are its main purposes, regardless of the chosen media. (Cronin 2009). In cartoon art that aims to convey information in an easily absorbed manner, emphasis is on the balance of visual elements and what kind of information they contain, because overly detailed cartoons easily lose the feeling of intimacy that simplified illustrations create with their directness. (Eisner 2008, XV, 44; Salgood 2015, 0:50:00.) These elements include lines, dots, forms, colors, contrast and the combinations that are created by them, such as silhouette, direction, symbolism and mood. With proper and direct portraying of details, for example, the bulking muscles of a raging barbarian hero or the glimmering eyes of a gentle oriental princess become more compelling!

As a proof of the universal use of readability guidelines, tips for web designers were partially used as a reference. The next sections describe what kind of variables can affect readability.

### 2.1 Target group

Readability of content does not rely solely on the visual presentation that artists put together, because the people that read or see the artists' creations have variable personal histories, cultural backgrounds and education. Readability therefore needs to be set to an appropriate level based on the aforementioned qualities, since recognizable, familiar images make the viewers recall their own experiences about a specific subject, thus making them feel more appealing, realistic and comprehended quicker (Eisner 2008, 9).

Interpretations often happen subconsciously. For example, Schodt (1983, 92–93) brought up an event where a character's hair turns white in a scene that has inverted values for certain black elements in a black and white manga. This kind of change will not usually confuse Japanese readers, because they automatically assume that every Japanese char-

acter has black hair if it is not stated otherwise. This interpretation is caused by the homogeneous genetics of Japanese people, as their hair color is most often very dark or black.

Symbolism can be used to enhance desirable effects or messages that characters convey. Some of them are familiar from other sources of entertainment and can be easily used, because people have learned to associate specific subjects with in-depth meanings, usually based on their society, upbringing or education. A character that suddenly grows horns from its brow can seem devious or evil, because some religions, such as Christianity, tell about horned demons that represent evil deeds (McCloud 2006, 94; Gummerrus Kustannus Oy 2009, 190–191). A character's readability therefore increases if a cartoonist includes visual hints that are familiar to the target group in one way or another. In the previous example, the demonic horns acted as a catalyst for creating an impression of the character's personality.

## **2.2 Character Design**

Character designs need to support alternative perception skills by having appropriate clarity. It can be strengthened with both visual means and clever psychological hints.

### **2.2.1 Art style**

Light-hearted series could have simple characters that put the biggest emphasis on clearly drawn expressions that show strong emotions and simplified elements, because their directness makes a person excited or attracted to the content right away when it interacts with that person's senses. Erotic series could play more with realistically detailed visuality for the sake of arousal, since it has an objectifying effect in cartoons (McCloud 1994, 44).

A clear example of both practices is *Panty and Stocking with Garterbelt* (2010) comedy anime. The series is mainly rendered in a cartoony style that reflects its snarky and rough humor with simplified anatomy and strong outlines (upper picture 1), but it also spices up

some scenes with realism that have more sensual feel and gentle outlines. The more realistic style is reserved for parts that show the two protagonists, Panty and Stocking, teasing the viewer with suggestive moves and poses when they use their special powers (lower picture 1). Based on this theory, the effect of objectification by giving a cartoon character more details is basically present in every transformation scene that different series show at key moments. By objectifying a character, the cartoonist can emphasize its otherness; make the hero or heroine feel more special than the other characters or the environment that are included in the scene (McCloud 1994, 44).



PICTURE 1. The heroines' appearances have a significant difference between the primary cartoony scenes and semi-realistic power-up scenes (Panty and Stocking with Garterbelt 2010).

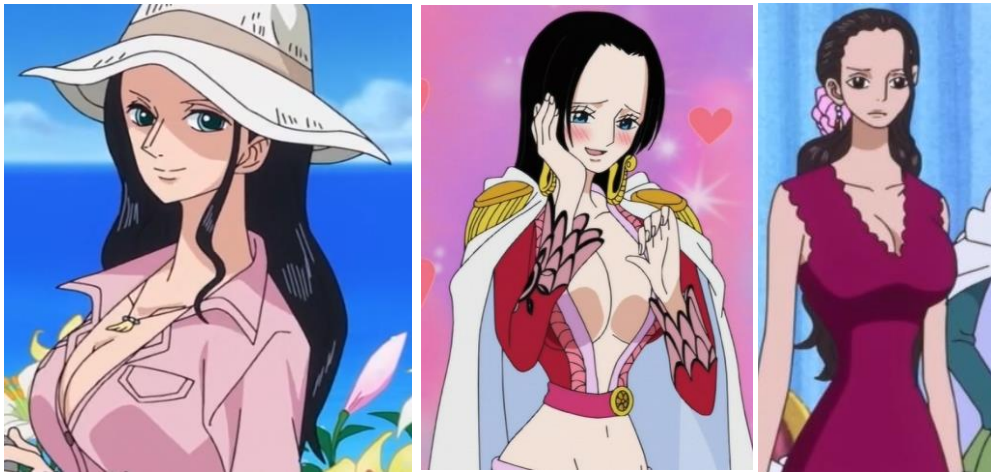
### 2.2.2 Colors

Some colors in cartoons are more appealing to certain groups of people. For example, bright colors are appealing and easy to distinguish for kids, because of their still-developing eye vision. (Pancare 2018.) Readability of characters in kids' cartoons therefore benefits from the use of basic colors, red, blue, green, yellow, orange, despite. Duller and darker color themes are more suitable with adult viewers. In the absence of colors, black and white cartoons rely on strong contrast and clearly illustrated elements.

### 2.2.3 Stereotypes

Classic stereotypes, like the damsel in distress, the muscular brute, the weak nerd, etc. are often used in entertainment to create instantly recognizable characters. In cartoons, different personalities are implied by relying on physical characteristics. Stereotypes are good for hastened readability, because they immediately give the reader hints about their probable personality without the need for establishing scenes or background stories for every side character. Visual variation is important though, because overly similar appearances that are masked with different clothes or hairstyles make tracking of individual characters hard due to lack of distinction and variety (McCloud 2006, 70–71, 73).

For example, Eiichiro Oda's *One Piece* (1997 & 1999) series is famous for its varied character designs, because it combines playfulness with absurdity. However, those qualities seem to apply mainly to the series' male characters that have unique silhouettes or details that make them easily distinguishable. Notable female characters have less variety in their character designs, because an hourglass-shaped body and a pretty face is the most standard look for their gender in the series. There are some exceptions that share the comical touch of male characters, but most often a female character's hair style, eye color or clothes are the only visual details that change if you compare her to another female character in the series (picture 2).



PICTURE 2. Characters' similar physical characteristics might confuse viewers. (One Piece 1999)

#### 2.2.4 Symbolic cues

In the same sense as classic stereotypes, characters' appearances can also be based on animals or geometric shapes to increase the readability of the character's nature, purpose or actions in a scene. The character does not have to look like an animal or geometric shape literally, but instead, the features can be tweaked so that they resemble the looks of specific animal or object. (Eisner 2008, 14; McCloud 2006, 73.) For example, a cunning female character's facial features could have a fox-like appearance, because people often see foxes as crafty creatures (Gummerrus Kustannus Oy 2009, 52), and it would strengthen the image that the character evokes in viewers' mind.

If this effect is examined further, symbolic cues can be used in situations where the creator wants to give hints about a character's inner thoughts in a way in which they are not actually visible to other characters. An example scene from *Naruto* would include an event where a male character promises that he will not peek into women's bathing area, but his face has turned into that of a rascal monkey and it reveals the man's true, opposite intentions to the viewer (picture 3). The underlying symbolism of the animalistic features would not be clear to other characters, only to the viewer as "secret" communication!



PICTURE 3. Character's inner thoughts or behaviour become clearer or more intense through visual cues that are symbolically linked to the action. (Naruto 2002)

### 2.2.5 Silhouette

Readability of silhouette is important for recognizing a character, because at their best, silhouettes can communicate with the viewer without words, color, sounds, lighting or intricate details. Simplification is often the key element, since it is easier to describe and understand something that has been built with the most essential features of human, animal or object. A good, thought-through silhouette can immediately tell you something about a person's age, gender, mood and actions, for example. (McDonnell.) A bad silhouette, on the other hand, can even affect the choice of camera angles in staging! A silhouette which looks good at eye level might turn into an incomprehensible "blob" when it is viewed directly from above or below. Characters with big heads or hats suffer from this issue, because that part's shape basically hides rest of the body's silhouette in certain angles.

Readability of actions is important especially in animated cartoons' fast action scenes, because it helps the audience to distinguish characters from each other and from the environment. It is crucial in games as well, because an unknown object or character might kill your game avatar if you do not recognize and react sufficiently quick to the possible threat. (Sabbagh 2015.) Dragon Ball Z, a series that has put emphasis on numeral fighting scenes, sometimes has so quick camera cuts between different shots in the most dynamic fights that it would be almost impossible to understand what is going on or who punched and what did he punch if the characters did not have distinct silhouettes (picture 4). It is even more important in their black and white manga, because artists do not have to be as

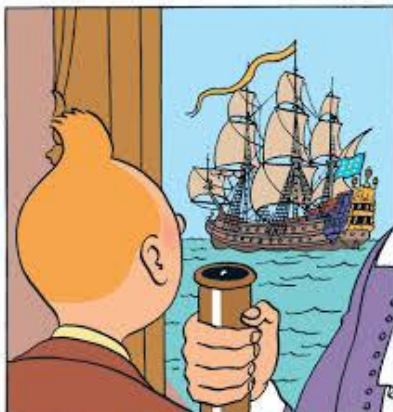


economical with details as they must be in the rapid production cycles of episodic animation series.



PICTURE 4. Readability benefits from unique silhouettes in quick and blurry action scenes. (Dragon Ball Z 1989)

Directionality is linked to silhouette too, as it refers to direction of characters or objects in space. Its importance comes forth when people try to follow the direction of other people's gaze, a behaviour that has background in humans' social and survival instincts, because humans tend to look for other person's eyes first. Hence back views of characters need some cues that help the viewer to understand where a character's eyes are and where they are most likely looking at. In The Adventures of Tintin comic series (Hergé 1943), Tintin's hairstyle works as an indicator of the direction of the character's face if facial features are completely or partly turned away from the reader (picture 5). This is an important detail due to the oval shape of his head, which does not offer visual cues as easily as realistically depicted heads do.



PICTURE 5. Tintin's hairstyle matches the direction of his face (Hergé 1943).

Betty Boop's hair is an opposite example of such design, because the curls of the character's hair nearly always retain their silhouette, despite the movements of the character's head. The character could be looking directly at the "camera", i.e. the viewer, or rotate her head left or right and the silhouette would still stay the same (picture 6). So unlike Tintin's lone tuft of hair, Betty Boop's curls have abstract quality that disregards depth and position in space.



PICTURE 6. Silhouette of the hair stays the same, regardless of the head's rotation. (Betty Boop's Little Pal 1934)

Silhouettes that partially follow camera movements are good at making easily recognizable character silhouettes, because they retain their iconic shapes, proportions and locations almost in any situation. Imagine the ears of Mickey Mouse for example and try to remember a moment when they did not look spherical. Such quality has drawbacks however, because they distort the clarity of character's direction. A person should be able to understand when a character is looking away based on a specific detail on its silhouette. But what happens if that detail, a snout or a wild hairstyle for example, faces the camera constantly in a same angle, instead of being fixed to its original spot and reflecting the main body part's actual direction? In such situations, it might be good to rely on personal judgement and find a compromise that produces the best readability for both the silhouette and any iconic feature if the latter's visibility is mandatory.



### 2.3 Contrasting details

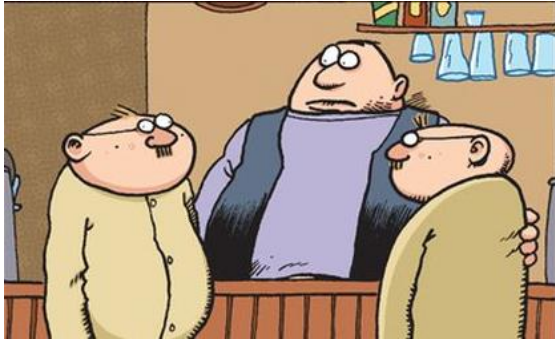
Character designs consist of various details that make them memorable, so it is important to create visual hierarchy for them. Visual hierarchy means that there are different levels of dominance between the visual elements and some details are more important than others. If there are too many of them, the viewer may not know where to look first and the character loses its nature of being easily absorbed content. Dominating visual elements are therefore beneficial for creating entry points into the design, because then the viewer can organize the presented visual information more easily. (Bradley 2010.)

Various types of contrast can be used to elevate one element above others. Value contrast is one of the most effective uses of contrast, since it relies on the power of bright and light values over dark and muted values to attract people's interest (Bradley 2010). For that reason, it is good to add dark colors and low contrast to areas that are not overly important for the first impression or quick readability. A character's shoes or intricate patterns on clothes of low interest would be less distracting if their value did not compete with facial features' values, for example. (Valve 2017.)

Another type of contrast is size contrast, that makes big objects dominate small objects. Objects and elements of bigger scale seem to be closer to the viewer and carry more visual weight, and thus draw interest first (Bradley 2010). The big eyes of anime characters work in that fashion if their exaggerated sizes are compared to other facial features, which are often depicted with simple lines and shapes (Schodt 1983, 91).

Density is the third type of contrast and it has two purposes. With selective separation, density makes a lone detail seem more important than the surrounding details, regardless of the separated parties' visual richness. In web and graphic design, the zone between the two parties is called white space. (Bradley 2010.) The separated lone elements basically become concentrated areas of interest when their size or number is considerably smaller than the areas that are considered as white space (Valve 2017). The white eyes in Batman's dark mask or the combination of tiny eyes and big heads in Fingerpori comics exemplify its effectivity (picture 7). The white space effect is used more often in black and white cartoons than colored cartoons, because the latter can use colors for distinguishing different elements from each other. For example, the creator of One Piece, Eiichiro Oda, draws highly detailed backgrounds and characters for the series' scenes and uses

white space effect for separating the cast from the environment (picture 8). In the animated version of One Piece, the effect is less crucial because of color usage.



PICTURE 7. Characters' eyes as the elements of lightest value draw viewers' gaze, but it can be amplified with large, scarcely detailed areas that surround them. (Fingerpori 2018a)



PICTURE 8. The empty white zones around the characters' upper bodies help them stand out amidst the dense environmental details and make them become areas of interest. (One Piece 1997)

## 2.4 Staging

Staging is a principle of animation that aims for clear presentation of ideas through acting, timing, setting, camera angle and its position. If they are done well, the artist can efficiently control the viewers' gaze from one important spot to another and make sure that irrelevant elements do not distract them (Becker 2015, 0:00:09). The purpose of staging is basically a synonym for cartoons' readability, hence it is best to take a quick look at what is important within a scene.

### **2.4.1 Acting and timing**

Clarity of acting and timing often work hand in hand. They make the viewer's attention jump from one area of interest to the next in a path that highlights one or two of them at a time (Becker 2015, 0:01:13). According to Scott McCloud (2006, 20, 34), "Readers focus on areas of change and relevance to the story" – a behaviour that can be controlled by making irrelevant elements seem stationary or repetitive. In a super hero comic for example, there can be a scene where the hero talks and his cape flows with wind. The reader would naturally pay attention to the character's moving mouth, because he wants to find out what the hero is saying, and ignore the flowing cape that has repetitive movement. The character's body would not get much attention either, because it is most likely in a stationary pose in that kind of monologue scene. In animated cartoons, the clarity of actions can be achieved by letting key movements and reactions have turns so they will not overwhelm the viewer by overlapping or competing with each other (Becker 2015; McCloud 2006, 34-35).

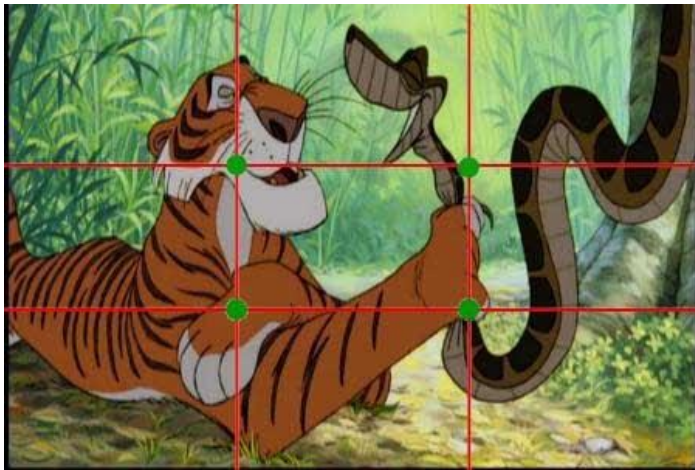
### **2.4.2 Camera angle and position**

The camera represents the viewer's point of view and the director or artist decides what angle or position is the best for examining a setting. A continuous stationary view into a scene makes the viewer focus on things that change within that framing, instead of getting distracted by restless shots that do not benefit narrative. However, varying shots make some scenes more interesting and highlight certain qualities. Special views make the viewer follow the happenings from a character's position or elevate them above the setting or main events so that they can get an overview of everything. The latter works as an establishing shot that can convey a mood or a sense of place. (McCloud 2006, 18-23).

The effect of different camera angles can be examined by comparing comics from the early and latter half of 20<sup>th</sup> century. Early comic artists tended to depict events with camera angles that showed characters' full figures and environments that had diagrammatic layouts. Both elements were practical at presenting information in a clear, yet uninteresting manner. Nowadays, because of the dynamic staging and drawing practices of manga artist Osamu Tezuka in the late 1940s and cartoon artist Jack Kirby in the 1960s, comics

evoke moods through livelier drawing styles and changing camera angles. (Schodt 1983, 62-63; McCloud 2006, 225).

A picture's "hot spots" can be also used for directing viewers' eyes to desired details. Hot spots refer to the center of the view or one of the thirds of the view (picture 9), which are based on the rule of thirds that makes elements catch attention more easily if they are near certain regions in a picture (Doucet). Movements in animations can surpass the effect of the hot spots though. They additionally convey the absence of important elements, an object's motion, objects of interest that are not visible yet, the distance that has been crossed or about to be crossed (McCloud 2006, 25).



PICTURE 9. Animation frame divided into the thirds of the view. The green dots represent hot spots of interest. (Doucet)

### 2.4.3 Visual cues

Presenting ideas to the viewers becomes easier through visual cues. Whether they are the character's mood or the items that decorate the walls of the character's home, they all become more effective at helping the viewers concentrate on the main concept if they are presented selectively (Becker 2015, 0:01:39). In cartoons, this usually means exaggeration, which removes the subtlety of realism and highlights the purest essence of its subjects (McCloud 1994, 30). Character design's effects to readability was already examined earlier, but the effect extends to non-character objects as well! In the building phase of a setting, it is best to include objects that are the most relevant for giving an impression

about a character or space. Irrelevant objects would just degrade the overall impression. (Becker 2015, 0:01:49).

Cartoons also use the effect in a reverse manner to strengthen the viewer's attention to a specific subject. It means the important character, object or other detail is completely isolated in a simple abstract space for a moment and returned to the initial "location" when the effect has fulfilled its purpose (picture 10). The sudden disappearance or simplification of possibly distracting surroundings forces the viewer to concentrate only on the things that exist in the abstract space, thus improving staging and readability of important elements.



PICTURE 10. Characters seem to move into another space in shocking moments (upper picture), but they are actually in the same spot the whole time (lower picture). (My Hero Academia 2016)

### 3 THE NATURE OF CARTOON ART

#### 3.1 Simplicity as the base

Cartoons have a distinct visual style that primarily uses various types of lines for depicting characters and it can be seen as their biggest visual characteristic. Such a simplified way of presentation has given cartoons a reputation as a medium of light-hearted and easily readable content. That is not an unfounded accusation however, because cartoons have catered to people of low literacy and limited intellectual accomplishment for decades. (Eisner 2008.) That basically means the visual style of cartoons was partly affected by their role as children's entertainment - in the case of cartoons and comics from the early 20<sup>th</sup> century at least.

Another influential effect came from printing methods that limited the way how cartoons were presented before the support for larger color palettes became common. Early printers often provided only a handful of colors and cartoonists had to be content with them in their character designs. For example, the iconic skin color of Marvel's Hulk was gray in one of the early iterations, but it had to be switched to green, because the former choice could not be reliably reproduced every time. (Grais.)

Simplified visual elements of cartoon characters do not imply that they lack adequate details though. On the contrary, every line and dot contains information that tells or gives cues about the nature of the part that they partially or wholly depict (Salgood 2015). If facial features of anime characters are examined for example, it can be seen a couple of simple lines is enough for giving an impression that a character has nose and mouth (picture 11).





PICTURE 11. Despite the lack of visible lips and nostrils, just two lines can create credible forms for nose and mouth. (My Hero Academia 2016)

The extent of simplification often matches the intended mood of the story or illustration, for highly detailed and realistic style is usually reserved for cartoons that cater to adults and minimalistic style is saved for children's cartoons. Nowadays realistic depictions of characters do not belong exclusively to adults' series, as childish cartoons also occasionally use shots with increased realism as a mean to increase graveness of a situation (picture 12). Realistic shots of items and other inanimate objects are used in a similar manner to make the viewer aware of them as objects of interest. This kind of practice is highly common amongst Japanese series that are usually more creative with stylized special effects than their western counterparts. (McCloud 1994, 43-44)



PICTURE 12. Sudden realism makes characters' reactions seem more intense if realistic style is atypical for the series. (Daily Lives of High School Boys 2012)

Simplified style should not come at the expense of readability, as character's lines can turn into incomprehensible scribbles if they are not drawn with clarity. As cartoonist Scott McCloud (2006, 26) stated it "No matter what style of image you choose, your pictures' first and most important job is to communicate quickly, clearly and compellingly with the

reader”. This is true especially with characters, because the power of their expressions lies in their ability to depict basic human emotions. (McCloud 2006, 81-82.)

People fortunately tend to see human-like features even in the simplest of forms that suggest human anatomy with symmetrically placed features, so stylized and simplified character art is not a problem (McCloud 2006, 59-61). A good way to visualize this is the difference between realistic portrait paintings and cartoon caricatures, because the former would try to depict a person in realistic manner with proper perspective and lighting. The latter, on the other hand, would probably look like a sketch that only uses few lines and exaggeration for emphasizing the person’s most prominent features. In the end, the portrait and the caricature would look slightly different because of stylization, but both would still represent the same person. In other words, both depictions contain the same information that makes the character recognizable. As a conclusion, simplification is a way for cartoons to ensure clarity for the most important details only, because they help the audience understand what the cartoonist wants to tell and make them become interested in the content (McCloud 2006, 9).

### **3.2 Abstract Art**

To understand the stylized look of cartoons better, it is good to look at the theory of abstract art, as they share many similarities. Artists have always utilized abstract shapes to improve compositions, but abstract art as an artistic movement became popular in the early 20<sup>th</sup> century, because it threw away some of the conventions that had been forced on artworks. Instead of imitating visual reality accurately, abstract art started to represent it with simplified shapes, colors, and forms that would give artworks dreamlike or nightmarish qualities in the most extreme cases. (Caterina 2017.) Despite the otherworldly look, the simplified style was usually achieved by taking or separating elements from an object, figure or landscape that existed in the real world.

Symbols in abstract art can also be used to depict and represent subjects that do not have physical forms. It means that an artist can use strokes and paint marks, for example, in a manner that would portray his emotions or state of mind when another person looks at the artwork. (Tate a.) Cartoonists similarly utilize visible gusts of air and “speed lines” to



give detectable forms to movement. In the case of speed lines, they complement and exaggerate the feel of movement in scenes that would otherwise look static. For example, speed lines make fighting scenes look faster than one animation frame or a comic panel could suggest on its own. Speed lines also depict the trails of movement if the cartoon only shows the start and end poses of the most fastest actions (picture 13).



PICTURE 13. Some actions of the characters in Dragon Ball Z appear so quick that speed lines are the only indicators of movement interpolation between the starting and ending point of an action (Dragon Ball Z 1989).

The main appeal of abstract art is the theory that it lets artists aim for aesthetic experiences that exhibit pure patterns of form, color and line. (Tate b). That theory impeccably matches the general idea and feel of cartoon art, as various cartoon series have shown with their stylized depictions of characters and their actions.

### 3.2.1 Mind fills the holes

Abstraction and its tendency of withdrawing details might sometimes make character art look unfinished, due to missing or incomplete lines. The hair of Tintin or Heimo Vesa or the eyelashes of Betty Boop are good examples of this, because their creators have simplified the parts by only using a few lines and gaps to depict necessary details. That kind of stylization benefits from the fact that the human mind does not register every detail when a person looks at something, because some areas are less focused than others. Areas with dense body hair prove this theory, as human eye does not simultaneously see every strand of hair - they are seen as a unified mass instead.

### 3.2.2 Details bring the person

Abstraction can be used to make a character so simplified that it loses its uniqueness and becomes a “mannequin” that could represent anyone. For example, some Japanese comics use simple character designs with visual traits that are common to the local populace, because they help the reader identify with certain characters and their incidents. (Picture 14). If the character suddenly had more defined features though, it would start to feel like a unique person and thus lose the sameness that it had with the reader. (McCloud 1994, 31; Schodt 2013, 112). This effect is induced by the theory that people see other people accurately, but they do not have an accurate image of their own face in their mind. A person only has a general idea of their most prominent features, which basically represents a rough sketch and it coincidentally matches the way how cartoons are drawn. (McCloud 1994, 36.)



PICTURE 14. A generic main character could represent almost anyone. (Drunk Salaryman 2012)

### 3.3 Seven elements of art

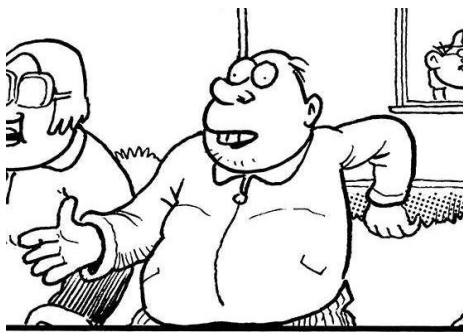
Identifying the “building blocks” of an artwork works as a base for using simplification and abstraction in cartoon art. These building blocks are better known as the seven elements of art and they are called line, shape, value, color, pattern, texture and form. They can be used individually to emphasize a certain characteristic or in combinations that create relationships between the elements. (Artyfactory a.) A cartoonist could, for example, draw a circle with a line and it would create the shape of eyeball or add more lines inside the circle so that it turns into a texture and starts to resemble a ball of thread. The

following paragraphs look further into the nature of these elements and try to identify what kind of information they can contain or represent if their characteristics are changed or emphasized in a particular manner.

### 3.3.1 Line

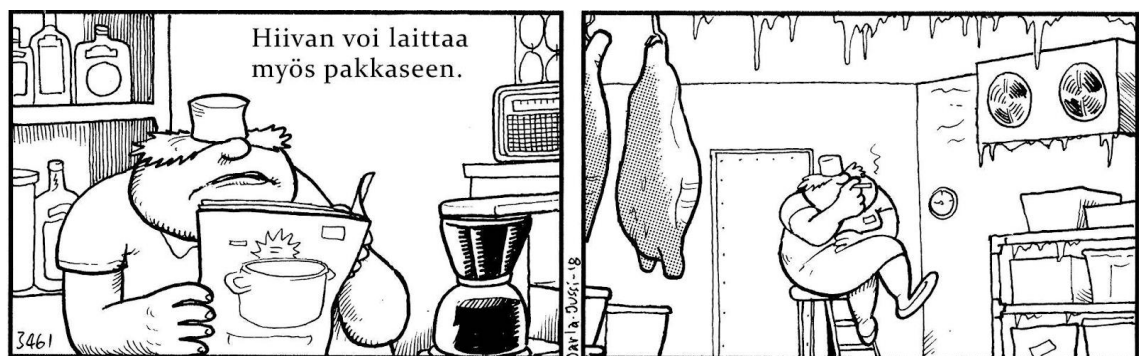
A line represents a moving dot and it is the most versatile visual element that can suggest various things: shape, pattern, form, structure, growth, depth, distance, rhythm, movement and a range of emotions (Artyfactory b). The most common objectives of a line are defining edges of an object, contribute for something and be expressive (Fussell 2010; Salgood 2015). That is important in a simplified style of cartoons, since every line contains information. In character art for example, Salgood recommends using thick lines for thick areas like muscles and thin lines for areas that have bones, elbows and wrists. These line variations suggest that muscles have bigger mass than most bones.

Line weights are also used for depicting highlights and shadows, because cartoons are often drawn in a style that does not represent realistic shading. Both Fussell and Salgood illustrate this by reserving thick lines for edges in shaded areas and thin lines for edges in lit areas. The variations of lines are basically giving visual cues about the light source even if the character has no actual shading (Salgood 2015). If lighting in cartoons is examined in depth though, it usually matches Rembrandt lighting or three-quarter lighting, a lighting style that is effective at bringing out most details of character's body. Its usage is evident if the outlines in the characters' back are thicker than frontal outlines (picture 15). These line weights create edges that efficiently separate the character from objects in the background.



PICTURE 15. The thick outlines in the back of the character's torso and left arm suggest Rembrandt lighting (Fingerpori 2018b).

Line weight also gives the impression of distance and depth, because lines are a part of a character and they both simultaneously become smaller if the character is further away. Fingerpori and Betty Boop cartoons use line weights in this manner, but the only deviation is the thickness of important characters' or objects' outlines that are occasionally thicker than other subjects' outlines. However, it should be noted that creators of Betty Boop cartoons might have used transparent cels in the animation process in the 1930s and overlapped slides could have decreased the contrast of lowest cels, which have usually been reserved for details that do not move constantly – environmental details in this case. Because the aforementioned cartoons are often depicted in black and white or grayscale style that do not benefit from distinguishable color variation, thick outlines help important subjects pop up if they are faraway in the scene or they are surrounded by dense environmental details (picture 16 & 17). Using bold outlines seems to confirm effectivity of contrast, because bold, black outlines clearly tell the viewer where a character's parts end and the environment begins.



PICTURE 16. The character's outlines are thicker than the outlines of props that are roughly as far as her in the setting. (Fingerpori 2018c)



PICTURE 17. The thick, black outlines of Betty Boop, the clock hands, the birds, and the logs in the fireplace highlight their importance in the shot. (Betty Boop in *Red Hot Mamma* 1934)

Hergé's *The Adventures of Tintin* comics have flat values and nearly absent shading, but it gets a lively feel from varying line weights. It is illustrated by using different line thicknesses for indicating the weight and lightness of objects and materials (picture 18). Clothes of different characters in the comics also show that white and other light colors do not automatically get thin outlines despite their bright value. For example, Tintin's white socks have thinner outlines than another character's baggy shirt sleeves that are white as well. This gives an impression of different materials: Tintin's socks seem to be made from a thin material that is neatly wrapped around the form of the leg, while the shirt sleeves feel like heavier material because of its thick outlines that also emphasize bigger mass.



PICTURE 18. Tintin's jacket seems the heaviest piece of clothing because of its thick outlines, while socks and their material look light and thin. The dog's white fur looks fluffy for the same reason. (Hergé 1947)

### 3.3.2 Shape

Shape is a two-dimensional area that only has width and length. Shapes can be defined with an enclosed outline or made with other shapes that are arranged so that they create an enclosed area that is treated as a new shape. By treating one shape as a positive shape and other shapes that surround it as negative shapes helps a person to understand what he or she sees even if a picture contains complicated forms. (Lumen Learning.) Traffic sign designers rely on people's ability to divide elements into two or more groups by color, for example (picture 19).



PICTURE 19. Despite the cryptic combination of shapes, a person can understand the meaning of this traffic sign if the black shapes are seen as a combined positive shape and the yellow shapes are seen as a combined negative shape. In this case, the yellow shapes turn into a canvas that is used for the silhouette-like scene that the black shapes depict. (22 Words)

Various parts of human anatomy also become more easily understandable and their basic forms clearer if they are imagined as simple shapes. This has been the tool for cartoonists for ages, as they have turned eyes of their characters into simple white spheres, nostrils into two dots, navels and ears into curvy coil shapes and so forth.

Hairstyles in cartoons benefit from shape distinguishing and abstract art's placement and size tricks that create the illusion of depth as well, instead of using actual perspective depth. This is pronounced with black or dark elements, because of their low contrast in black and white cartoons. Darkly colored hair usually shows glossiness and the strongest of highlights or none at all in *Naruto*, *Dragon Ball Z* or *Betty Boop* series, for example. Because of this reason, hair styles of dark-haired characters are often not as detailed or three-dimensional as their lighter counterparts, because they rely more on their silhouette-like shape than showing inner lines that define forms.

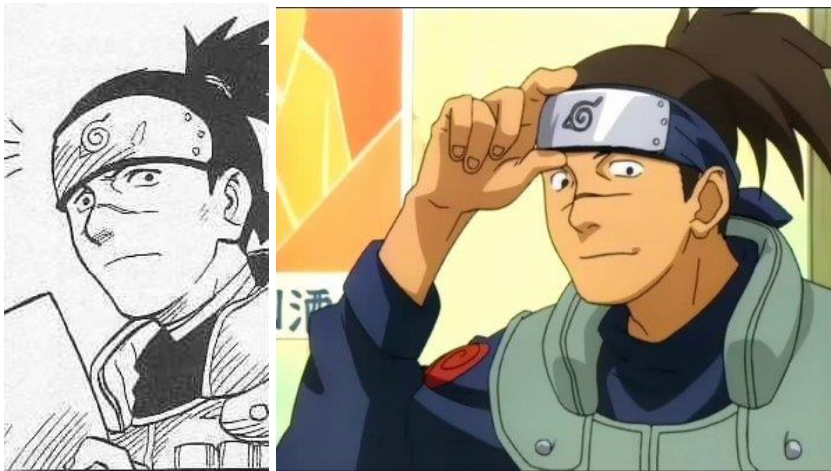
### 3.3.3 Value

Value is a measurement that refers to the darkness or lightness of a color. Colors can have infinite number of values and they are adjusted by adding white or black, because white



is the lightest value and black is the darkest. An artist could, for example, add white to blue to make it brighter for an illustration that depicts bright day sky or add black to match darker sky of a nightly scene. Value also creates the illusion of form if a visual element or a block of color has values that show contrast by shifting from darker to lighter values or vice versa.

If black and white cartoons are excluded, cartoons' simplified nature is apparent in the way how they separate the values of highlighted areas and shaded areas into two or three layers. The use of "layered shading" can be imagined as a pruned version of realistic shading that uses smooth value transitions from shaded areas into bright areas (picture 20). In real life, objects that show clear borders between differently illuminated areas are usually brightly lit, reflective or they have hard edges that suddenly create shadows. Despite the layered style of shading in cartoons, the strongest value contrasts are usually saved for scenes that require specific mood. Characters have nearly similar values for their highlights and shaded areas in scenes that have basic lighting conditions, because lines can be coincidentally counted as an extra layer of shading. This coincidence is created by the value of lines that is usually the darkest value on any character. This can be based on the theory of occlusion shadows that appear in the least lit crevices or areas where two surfaces meet (Prokopenko 2012).



PICTURE 20. Colored cartoons can depict differently lit areas broadly and sharply with value layers, but they lose the ability to show the forms of shaded areas as accurately as lines can in black and white cartoons (Naruto 1999, 2002).



Black and white cartoons have handled shading of medium lit areas with lines that illustrate fading illumination. Due to the lines' ability of giving information about forms with curves and other qualities, they do not depict shaded areas as flat as layered shading does. On the other hand, layered shading excels at shading reflective materials, because of its ability to use clear jumps and contrast between values.

### **3.3.4 Color**

Colors refer to the experience that happens when wavelengths of light hit a light-sensitive receptor cells called rods and cones in the retina of a person's eye and he or she interprets the light's quality as a color. People with defective cells might have difficulties to interpret colors in the same way as other people and are known as color-deficient. (Starr 2017; Leong 2006)

Different wavelengths represent different colors, but humans create their own interpretations and it means that an apple might seem red to one person, while it is blue to someone else in the most extreme cases. Neither of them is wrong, because the interpretation happens in the person's mind and it is based on the viewed objects' or scene's lighting source and environment. On the other hand, human mind might make wrong interpretations based on the person's existing knowledge about specific subjects. (Starr 2017). For example, the aforementioned apple might seem red to the viewer in teal lighting, because his brain tells him that apples are red. However, the color of the apple might actually be gray in that situation, but the person's brain, once again, made it seem red.

Despite the fact that people see colors a bit differently in some cases, it has been studied that colors can affect humans mentally and emotionally (Nassau). Hence they are convenient for creating mood and atmosphere in cartoons that can exaggerate colors of the real world to better match their goals.

### **3.3.5 Pattern**

Patterns consist of “echoed” or repeated visual elements that give the impression of balance, harmony, contrast, rhythm, or movement, which can be natural or man-made. As the name implies, natural patterns can be found in the nature as fur markings, spirals in seashells, intricate branches etc. Man-made patterns are mainly used for decoration or structural purposes by humans. Despite their different sources, both patterns can have various appearances from regular and geometric to chaotic and organic. (Artyfactory c.)

Cartoonists utilize a wide range of patterns in their art, because they can be effectively used for giving illusion of simplified reality. Cartoons use patterns for eyelashes and hair to create the illusion of volume, for example.

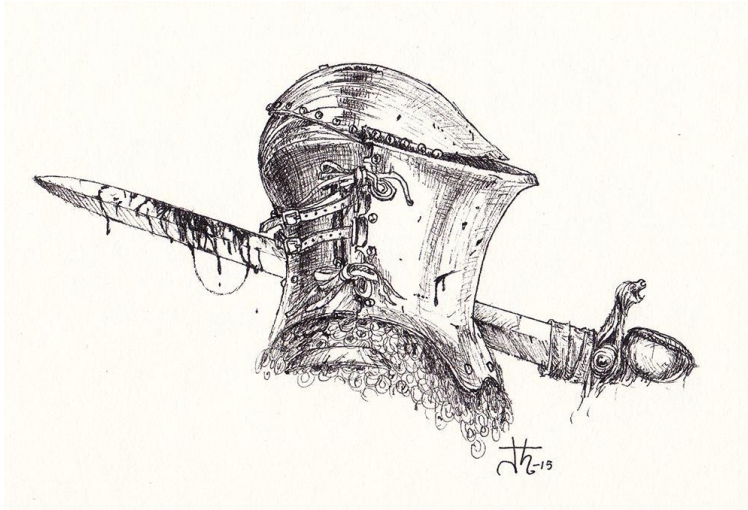
### **3.3.6 Texture**

Texture as an element of art refers to the surface quality of material and how it might feel if it was touched. Textures can imply whether a specific material’s surface is rough or smooth, for example. In cartoons, texture is usually created with lines, contrast or hue changes. Black and white cartoons shading style might give wrong impressions about textures, because some lines could be mistaken for textures. Hence it is important that cartoonist remembers to simplify textures to a point where the most essential lines are kept and unnecessary elements are gone (McCloud 1994, 30).

### **3.3.7 Form**

Form represents objects that have width, height and depth. These characteristics make forms 3D objects that have their own volume in space. Because of this same reason, forms can also be used to create illusion of depth on 2D surface. If forms are compared to shapes, the third dimension of depth turns squares into cubes, circles into spheres and triangles into pyramids. Use of light and shadow help viewers to see forms as 3D objects, because otherwise they would just look like flat shapes. (Pantelić 2016)

Cartoons use lines and cross hatching to create forms with depth, because they can be drawn to illustrate the curves and edges on a surface. Cross hatching's objective especially is to give cues about forms that are inside the edges of an object, because its line-like effect only exists on the surface of the model (Picture 21). Where values and texture are limited, the effect of lines and cross hatching can be used for the illusion of forms, especially when they are used for shadows.



PICTURE 21. The helmet's forms and shading have been depicted with cross hatching. (Jarmo Hirvikoski 2015)

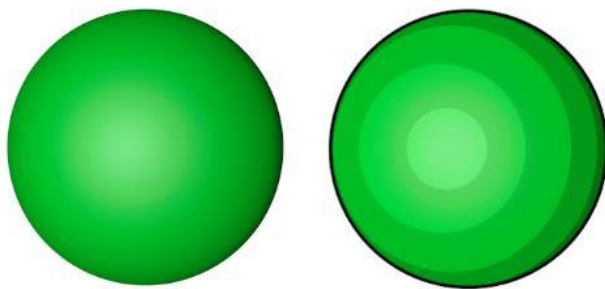
## 4 USE OF 3D MODELS IN CARTOONS

What are the benefits of using 3D models in 2D cartoon creating? Animation productions often suffer from rapid production paces, which force producers to cut corners and make compromises for the sake of saving time for more important parts. Hence animation studios sometimes decide to simultaneously use 3D and 2D graphics, because their combination makes the production of specific parts quicker and easier. The success of combining the different qualities of 3D and 2D mediums has various challenges and the next sections examine a few of them.

### 4.1 Rendering style

Various rendering styles have been designed for 3D animations. Emulating a cartoony 2D look with 3D models or going with the realistic shading style that 3D softwares provide as a standard feature are two common options.

For recreating the traditional 2D shading style of cartoons, a rendering technique called “cel shading” could be used. It renders 3D objects in an unrealistic style that replaces smooth realistic shading with a layered shading and outlines (Luque 2012, 1. Picture 22). Since cel shading matches the look of cartoons, complementing 2D scenes with 3D models becomes easier.



PICTURE 22. The sphere on the left is realistically shaded and the sphere on the right is cel shaded to look cartoony. (Luque 2012)

If a realistic style is used, a 3D object in a 2D scene might look out of place, because its appearance conflicts with the style of other elements due to shading or textures (picture

23). Hence it is important that every part mimics the intended final look of the cartoon. This can be linked to the effect of objectification that uses extra details as a mean to increase an object's or character's importance. In this case, the effect works in a bad way, because the gap between visual styles is too big, it is present in scenes that do not ask for it, and the mismatch distracts viewers away from following the actual content.



PICTURE 23. Too realistically shaded and textured armor plates do not always match the simplified look of the character's face, hair and cape. (Berserk 2016)

## 4.2 Lighting

Lighting is linked to rendering, but it has its own qualities that create challenges. Artists can make preference-based decisions regarding lighting and shading of characters to create a look that represents elements with adequate readability. Computer-generated shading is based on mathematical calculations that do not care about pleasing readability though. Because of that, shadows and highlights might be in locations that give characters unfavourable lighting effects that block or alter the readability of details. To avoid that kind of problems, some 3D softwares offer tools for manually tweaking the way how specific areas react to lights and shadows. For example, the creators of Guilty Gear Xrd and Dragon Ball FighterZ games reversed values in specific areas of characters' faces so that unwanted shadows disappeared and highlighted areas expanded to cover those spots (picture 24). In Dragon Ball FighterZ, which is based on Dragon Ball Z cartoons, the tweaking was taken to a point where the game's graphics accurately matched the original

look of the cartoons. Hence unrealistically settled shadows might be needed to improve readability of certain elements of 3D-modelled characters.



PICTURE 24. The third face on the right shows the original shading result based on a computer's calculations. Highlights and shadows have been manually adjusted in the first and second pictures for better representation of the character's facial features in cartoon style. (Motomura 2015. Modified.)

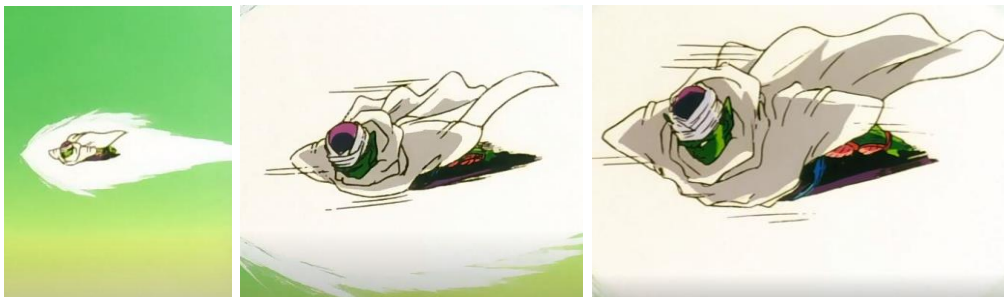
### 4.3 Abstract elements

Abstract elements are probably the trickiest feature to properly execute in 3D, because of their flexible nature that occasionally ignores perspective and depth, simplifies details, and plays with shading. It means abstract elements do not follow the same rules that the main body of the character or conjoined parts must follow to depict credible reality. A famous example of this would be the ears of Mickey Mouse that seem to ignore his head's angle completely and slide across its surface – a behaviour that allows the ears to stay visible in every camera angle and retain their iconic spherical silhouette (picture 25). It gives the impression that his ears are “looking” directly at the camera all the time. A 2D artist would just draw the ears as spheres in every scene and it would immediately make them look natural, because of the stylized look of cartoons. The 2D artist might have to be careful with the character's other non-realistic features though. A 3D artist, on the other hand, would have to take 3D software's technical limitations into account to achieve the same effect, because 3D-modelled characters are usually animated with rigs or “digital skeletons” that try to mimic the capabilities of realistic anatomy in 3D space.



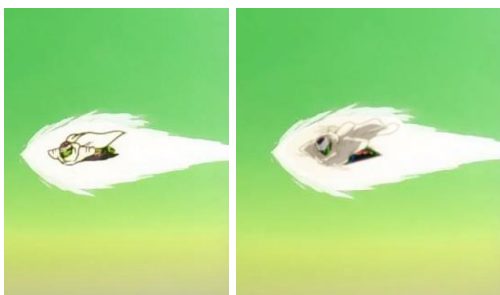
PICTURE 25. The angle and location of Minnie’s ears are not strictly fixed to the head. (Minnie’s Bow-Toons 2017)

Simplification represents another type of abstract elements and it can be constant or gradual (McCloud 1994, 29). Constant simplification of details can be countered in the conceptual phase before the actual 3D modelling phase has begun. Those details are the character’s physical details that can be handled by creating appropriate 3D forms for them or depicting them with textures. Simplification that happens gradually has to be countered in a different manner, because their alternating visibility and forms require animation or controlling. An example of this could be a scene where a character is faraway in the beginning and then gets closer to the camera. For better readability in 2D cartoons, the character would have less details than normally in the initial faraway shot and then get more detailed and defined as he comes closer to the camera (picture 26). If the same scene was recreated in 3D, the 3D character model would seem less defined and detailed because of atmospheric perspective. The effects of atmospheric perspective refer to the situations when a subject’s contrast, hues or sharpness of details gets affected by distance (Christensen 2017. Appendix 1 & 2). Simplification of distant characters in cartoons therefore represents such effects by dropping details to ensure that different elements stay easily distinguishable even in faraway shots. Adding too many tiny details to a distant character would just turn them into unnecessary “visual noise”, because they cannot distinctly create visual interest at long distances. (Teguh 2018. Picture 27).



PICTURE 26. Gradually increasing detail level of an approaching character keeps its readability good at various distances. (Dragon Ball Z 1989)





PICTURE 27. A character's details might lose their clarity if they are not simplified in faraway shots. The left picture shows the original version and the right picture has character graphics that have been scaled down. (Dragon Ball Z 1989. Modified)

#### 4.4 Dynamic variation

Cartoon characters' liveliness owes much to the 2D medium's creation style that makes the editing of details easy in animation processes. Attempts at creating 3D adaptations of cartoons have often been unsuccessful for the very reason that rigid 3D models lack that liveliness. The liveliness is caused by dynamic variations of details that create the illusion of life. Characters in 2D cartoons fortuitously have imperfections in some animation frames that make their lines and details a bit wobbly, which create the said variations. An absence of such variations and wobbliness make 3D character's face, limbs, hair, etc. seem artificial or doll-like, because their movements are depicted too accurately in 3D space. Adding some exaggerated bulging, stretching or squeezing to certain parts of animation can break that artificial and monotonic feel, because it brings out the natural behaviour of human body. (Motomura 2015.) In other words, it is useful to exaggerate movements in the same way that 2D cartoons do. Cartoon artists Ollie Johnston and Frank Thomas at Disney even created a guide called "12 Principles of Animations" to help aspiring cartoon artists and animators create the illusion of life. The principles cover subjects about squash and stretch, anticipation, staging, straight ahead and pose to pose, follow through and overlapping action, slow-in and slow-out, arc, secondary action, timing, exaggeration, solid drawings and appeal. (Oh My Disney 2016)

Although the dynamic variations are beneficial, immovable or solid objects can work without them and hence they are used more frequently in 2D cartoons. They often work as props that complement scenes, instead of being constantly presented as objects of in-



terest. The use of inanimate 3D objects can be explained with their reusable and unchanging nature, because it means that artists do not have to draw recurring and complicated objects again and again if they can just use a 3D model that already has all the details (picture 28).



PICTURE 28. Scenes that include highly detailed solid objects are easier to create with matching 3D assets. (One Piece 1999)

## 5 RECREATING BETTY BOOP IN 3D

Cartoons have created a wide cavalcade of diverse characters and choosing one of them for 3D adaptation required a set of criterions. Betty Boop by Max Fleischer seemed like a good candidate, since there are not many 3D adaptations of her. “Betty Boop Bop” mobile rhythm game by Fowl Moon Studios in 2014 is one of the newest adaptations at least. Nowadays the character mainly appears in various forms of merchandise, often in illustrations or as collectible statues. Those statues and other figurines worked as the main inspiration for modelling Betty Boop in 3D, because some of her features do not look flattering if you look at them from certain angles. A character sheet from 1930s even mentions the head’s side profile as one of the problematic parts (Appendix 3).

Betty Boop’s character design also exhibits abstract qualities that most modern 3D animation characters do not have, so the adaptation idea seemed an interesting challenge! Recreating a handful of single animation frames from the original cartoons in 3D became the main method for comparing capabilities of the 3D-modelled Betty with those of the original 2D Betty. For that comparison, a 3D mesh and a character rig were needed. Applying the findings and practices about readability and staging to the final adaptations is therefore the practical part of the thesis.

### 5.1 Who is Betty Boop?

Betty Boop is a cartoon character created by cartoon animator Max Fleischer in the 1930s and a symbol of the decade’s debauchery. Jazz performer Helen Kane was said to be the character’s inspiration and the artist even sued Fleischer studios in 1932 when the fictitious Betty started to get more famous than her. According to Kane, Fleischer had stolen her personality, looks and the famous “Boop-oop-a-doop” phrase. However, later it was found out that Helen Kane had actually mimicked another performer, Baby Esther, who was the original source of the characterful behaviour. Kane’s lawsuit withered soon afterwards. Creators of Betty Boop did not know about the connection between Esther and Kane though, and acknowledged the latter as the true inspiration. (Pellet)

Betty Boop first debuted in a short animation *Dizzy Dishes* by Fleischer Studios, where she was depicted as an anthropomorphic woman with dog-like characteristics. Soon in the subsequent cartoons, Betty was turned fully into a human character with sexualized looks and pinup flavour. Despite her innocent nature, the appearance emphasized womanly curves: thighs, buttocks, breasts and arc of the spine that appealed to adult male audience. In later animations, changes in the Hollywood's moral values forced Fleischer Studios to tone down Betty Boop's carefree and somewhat brash image (picture 29). (Pelot.)

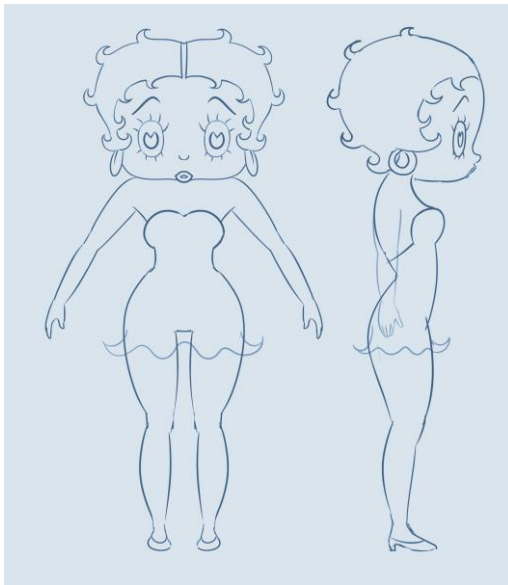


PICTURE 29. Betty Boop's visual style in chronological order from anthropomorphic to gracefully lady-like. (Fleischer Studios)

## 5.2 Concepting

Betty Boop's appearance that followed the anthropomorphic look was chosen as the main reference for the 3D adaptation. To retain proper proportions and understand how some of the details should be adjusted for 3D, cartoons and Fleischer Studios' original character sheets were examined (appendices 3 & 4). The source materials indicated that Betty Boop's distinct look is created through juvenilization – a trait that proportionately makes human's head big and legs short. Her neck is not visibly shown either, because the head is attached directly to the character's shoulders. The cartoons also ignore proper presentation of realistic anatomy in some cases due to abstract nature of the series' art style. Abstraction of certain elements was important to keep in mind, because it helps retaining the iconic features of the character. Curls of the hair were the most obvious feature, because they seem to retain their famous silhouette in every camera angle.

The various character sheets showed some small variations, but they nonetheless worked as an adequate reference for a new character sheet. A new one was needed, because character sheets for 3D modelling processes usually have full body views of characters in simple stand-up poses that clearly show the proportions and details from front, side and back view at least (picture 30). Fleischer Studios' character sheets illustrated Betty Boop mainly in curtsy poses that would had not been useful as such. The abstract nature makes some of her features behave differently than other parts when they are animated, so their positions and proportions did not have to depict their actual properties too accurately in the character sheet.

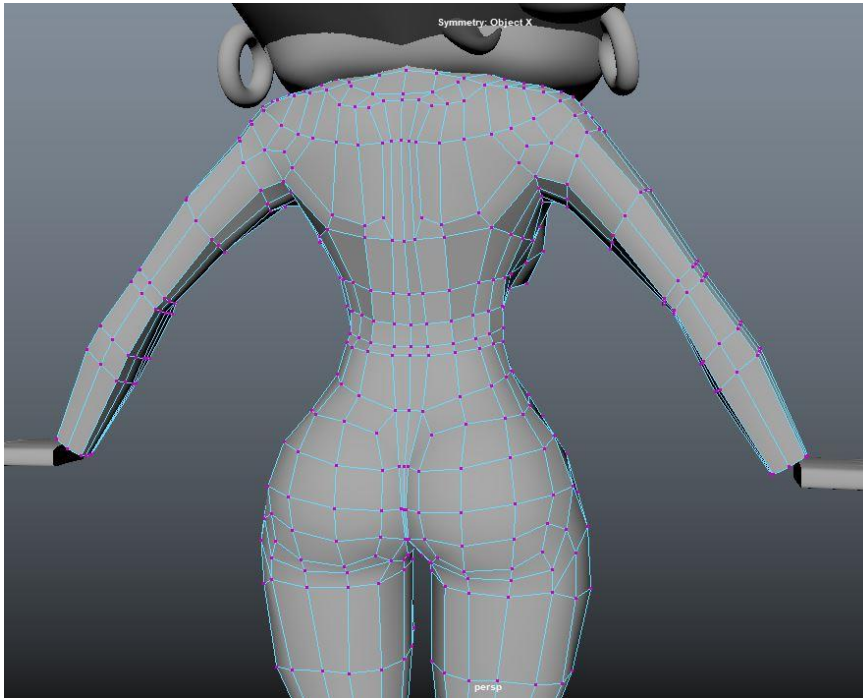


PICTURE 30. Betty Boop character sheet that was used as a reference in the 3D-modelling process.

### 5.3 Creating a base mesh

After the concepting and the self-made Betty Boop character sheet were finished, the latter was imported to Autodesk Maya 2018 as a referential image. A rough 3D mesh of the character was then created based on the images that were visible in orthographic front and side views. Betty's forms were about to be defined more in the next step of the modelling phase, but it was important to set "anatomical goals" for the model at this point. Her original character design implies the head is meant to look cute and doll-like while the rest of her body has more realistic anatomy for sex appeal (picture 31). In the cartoons,

Betty Boop's extra details occasionally bring out her female forms, which are often avoided in kid-friendly cartoons (picture 32).



PICTURE 31. Forms of the 3D-modelled body represented realistic anatomy more accurately than the dollish head.



PICTURE 32. Betty Boop has lines that make the curves of her back, buttocks and thighs visible. (Betty Boop in Red Hot Mamma 1934)

Modelling the head and body in 3D meant that a compromised style had to be found to avoid mismatch. A too realistically modelled body would have made the cartoony head look weird next to the body, because it would have slipped into “The Uncanny Valley”, an area of unfavourable human reaction to artificial humans, whose features are a little off,

yet too human-like (Schwarz 2013). Attaching non-human features to human bodies has similar effect in Marilyn Manson's Tainted Love music video (2001), for example (picture 33).



PICTURE 33. A disturbing conflict created by the combination of sensual female body and a big cartoony head was to be avoided with the Betty Boop model. (Tainted Love 2001)

Betty Boop's head and body do not have a conflicting relationship in the cartoons because of their uniform 2D art style. In 3D, the dollish feel of the simplified head is pronounced, because realistic shading has no problems at presenting the different forms and curves accurately. Hence the body had to be kept simplified and a bit rounded so that it would match the cartoony shapes of the head. So, for creating seductive curves and shapes, her body was modelled in a semi-realistic, but partially exaggerated style. A good balance had to be found so that viewers would concentrate on the big picture, not on the possible mismatch created by conflicting presentation of body parts.

Since cartoons rely on simplification, a cartoony feel of the character was also enhanced by depicting some details with textures instead of actual 3D forms. To add this kind of elements to the character, the iconic dress of Betty Boop was switched to a vintage swimming suit that made her midriff bare. Belly button, line of the spine, folds of the swimming suit's bow were drawn on the textures as simple lines as the result. The approach improved the readability of their primary details, which might have suffered from lighting issues if they were modelled in a manner that represents their intricate forms too accurately. Details of the eyes were already planned to reflect the original cartoon look, so

these additional elements helped that effect cover other parts of the body as well, allowing more balanced distribution of cartoon stylization. After the properties of textures and materials were tweaked to match the grayscale style of Betty Boop from the cartoons, the character model was ready for rigging (picture 34).



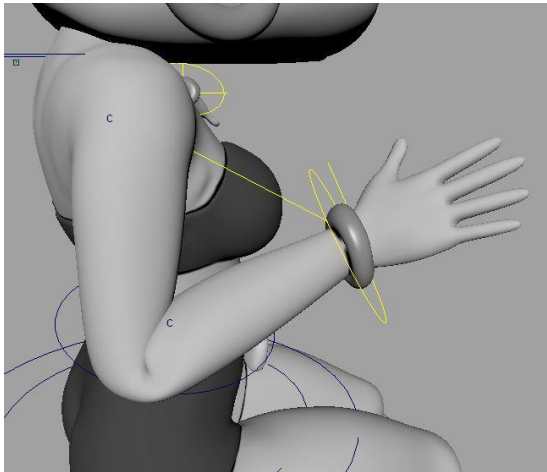
PICTURE 34. 3D model of Betty Boop with textures and materials.

#### 5.4 Rigging

The rigging of the character mesh was done by creating a set of joints and bones that formed a simple skeleton. The amount of bones in the spine, shoulders and fingers could not be too simplified though, because they were essential at creating seductive curves, the main players of Betty Boop's silhouette and appeal. A set of controllers were then created for the rig so that specific body parts could be moved easily without selecting any of the actual bones one by one. For example, some of the controllers were non-renderable circle



objects that rotated the character’s spine or pulled the limbs at a desired location in a natural manner (picture 35). Fingers were additionally controlled with numerical values that controlled their curvature, creating natural-looking poses for fully and partially closed fingers (picture 36).



PICTURE 35. Controller circles were used for easy handling of the character’s body and limbs.



PICTURE 36. Each finger’s “pose” was handled with a numerical value that represented poses from straight to closed.

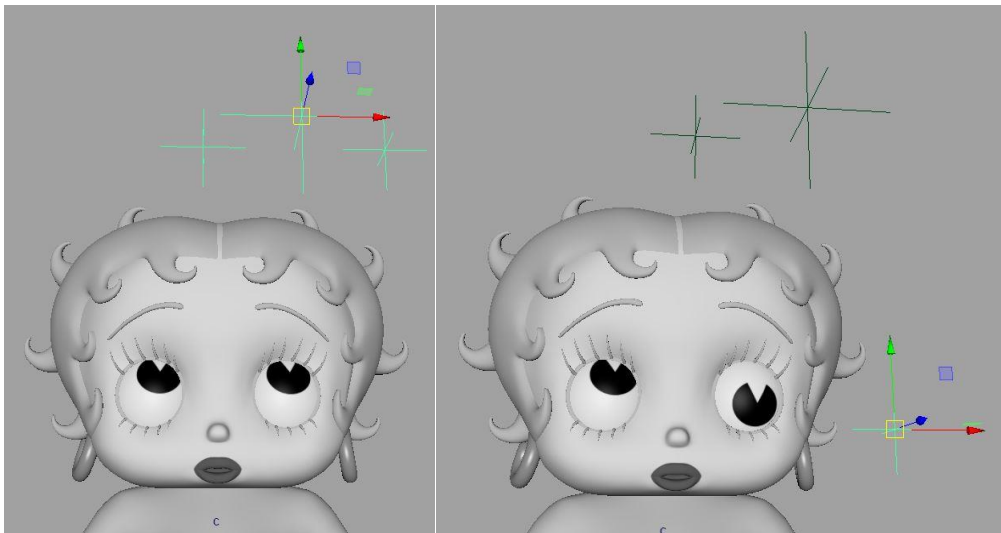
#### 5.4.1 Accurate gaze

The character’s eyeballs were made simply with spherical meshes that were wrapped with a cartoony eye texture. Controls for gaze were done with a separate controller object that worked as an aim point that both eyes followed constantly. Controls for a more accurate



gaze required a bit more work though, because the shared aim point did not support crossed eyes. Slightly crossed eyes are used to increase a character's cuteness too, so it was important to create additional gaze controls that would not move in tandem. Thus the shared aim point got two child objects, one for each eye, that ignored each other's movements.

The finished gaze controls allowed the eyes to move simultaneously if the shared aim point was moved and separately if one of the child objects was moved. Overlooking the support for crossed eyes or any other asymmetrical poses for them could have become an issue later if they had not been looked into, because Betty Boop's big eye size makes insufficient eye movements increasingly obvious (picture 37). Eyes play an important role in social interaction too, so readability of their movements had to be clear.



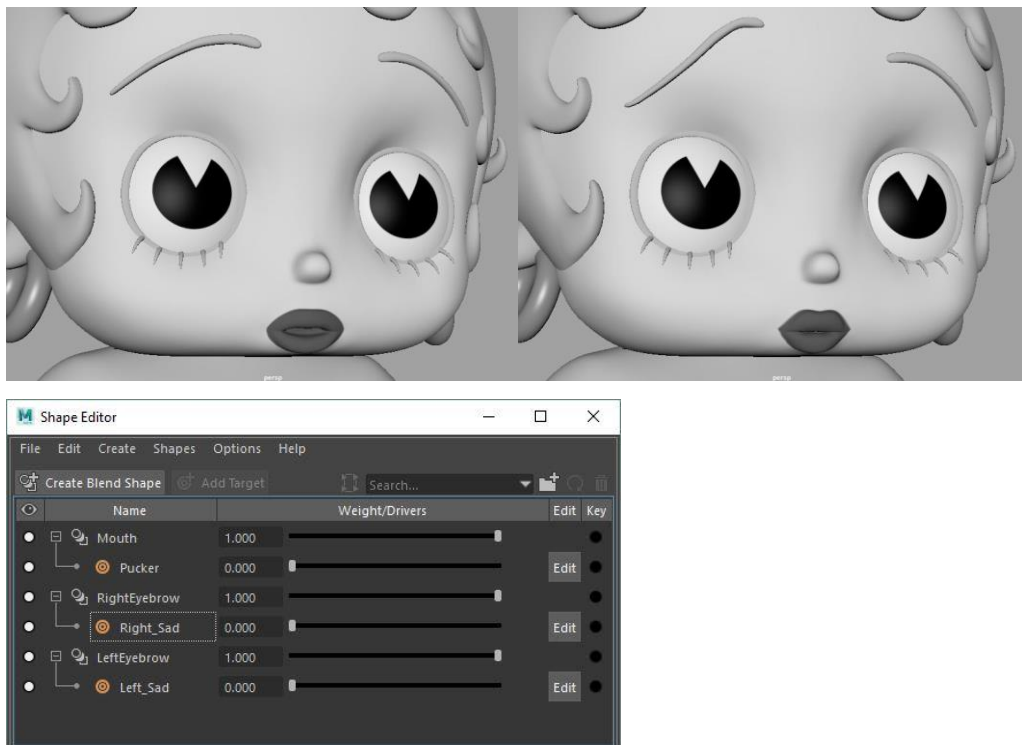
PICTURE 37. Shared aim control has moved both eyes in the left picture. In the right picture, the left eye's aim point has been used for an asymmetrical gaze.

#### 5.4.2 Facial expressions

The eyebrows of the Betty Boop model were created as 3D meshes instead of drawing them conventionally on the face's texture. The thin forms of the meshes match their original look from the cartoons that represent a simple curvy line. As the findings about the nature of lines indicated, they are the most flexible element of art and need extra attention for expressing that quality in 3D. Betty Boop's lips do not act as lively as eyebrows

though, because their tiny size and blackness do not highlight them easily. Hence the lips were simply painted on the face’s texture.

Rigging the eyebrows and lips with bones would have given them handy control points, but Maya’s “blend shape” function was more fitting, because it allowed the eyebrows and lips to be controlled in a flexible, clay-like manner. Their different poses just had to be “sculpted” on the actual meshes in a special editing mode and switching from one pose to another was done with a slider that controls the pose’s strength (picture 38).

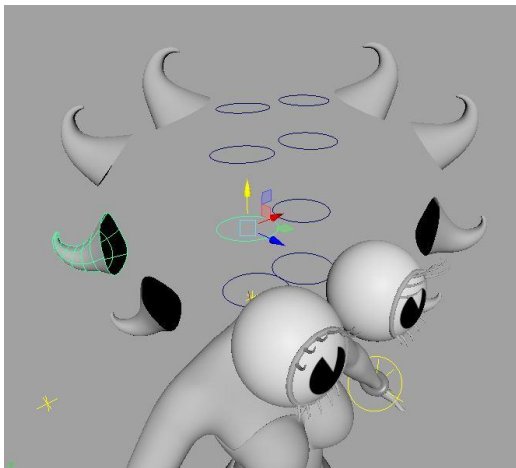


PICTURE 38. Controlling facial expressions with Shape Editor’s slider window in Maya. The left face shows the initial facial expression, while the right face’s right eyebrow and mouth has been driven to a different pose.

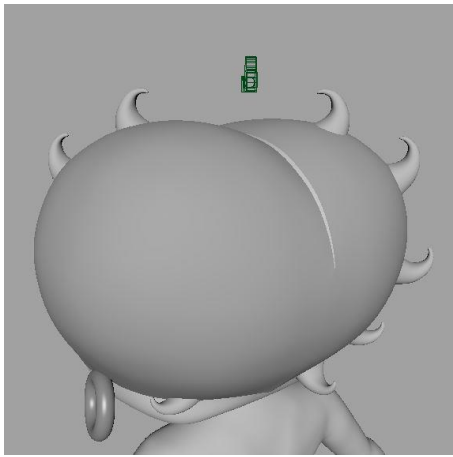
### 5.4.3 Hair silhouette

Curls in Betty Boop’s hair required the most complicated rig, because of their abstract nature. Since they are basically never hidden behind the head in the cartoons, it meant that they must be able to slide across the hair’s surface to more visible locations when the head or camera moves. Behaviour of Minnie Mouse’s ears in Minnie’s Bow-Toons suggested that their rotations always reflect the camera’s angle. To create a similar behaviour

in Maya, each curl had to be created as a separated mesh and rotation value of their Y axis were made to match the value of the camera's Y axis by linking the values. The true Y axis point of each curl was inserted inside the head to make the curls "orbit" around the external Y point rather than using their own position for rotations (picture 39). This kind of pairing forced the curls to make big curves around their Y axis points and ostensibly made them slide on the surface of the hair (picture 40). The curls' mobile nature was hidden with the hair's solid black color that showed no signs of shading. In other words, it benefitted from a very simplified type of cel shading that hid the border where the curls and rest of the hair mesh met. The black cel shading effect was also used in every dark element of the character, turning it into a recurring cartoon stylization that tied all the dark elements together.



PICTURE 39. The external Y axis points of the curls are visible if the head mesh is hidden. One of the curls has also been selected and Maya's moving tool is at the curls' Y axis point.



PICTURE 40. The curls have orbited around their hidden Y axes to face the green camera that has been connected to their Y axis value. In other words, the curls have “slid” across the surface of the large hair element.

Later testing revealed that it was better if one camera is parented to curls on the right side and a second camera is parented to curls on the left side. With two cameras, it was possible to pick one of them to be a main camera that is used for framing and rendering. The remaining camera had no other roles besides working as a glorified rotation tool in that situation, which was handy for showing curls of the other side in a pleasing angle if the pose of the head would otherwise hide them (picture 41). Despite the complicate nature of the hair silhouette rigs, they did not have any visible controllers that other parts had in the end of the character’s rigging process (picture 42).



The curls do not move if the scene is viewed through the working/editing camera.

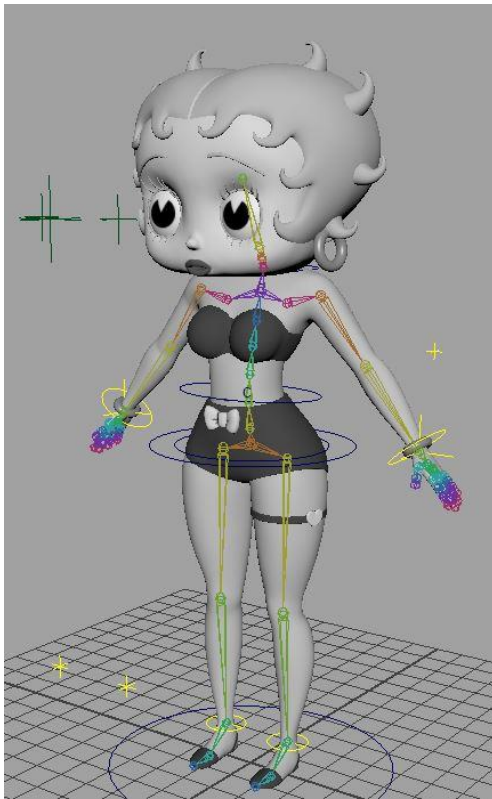


Curls on the right side rotate to match the camera’s angle if the scene is viewed through the camera that is linked to their Y axis. Same effect happens with the left curls if their camera is used for viewing instead.



The scene is viewed through the right curls’ camera. The left curls’ camera is not used for viewing, but it has been used as a “rotation tool” to change the left curls’ angle to create the iconic hair silhouette of Betty Boop.

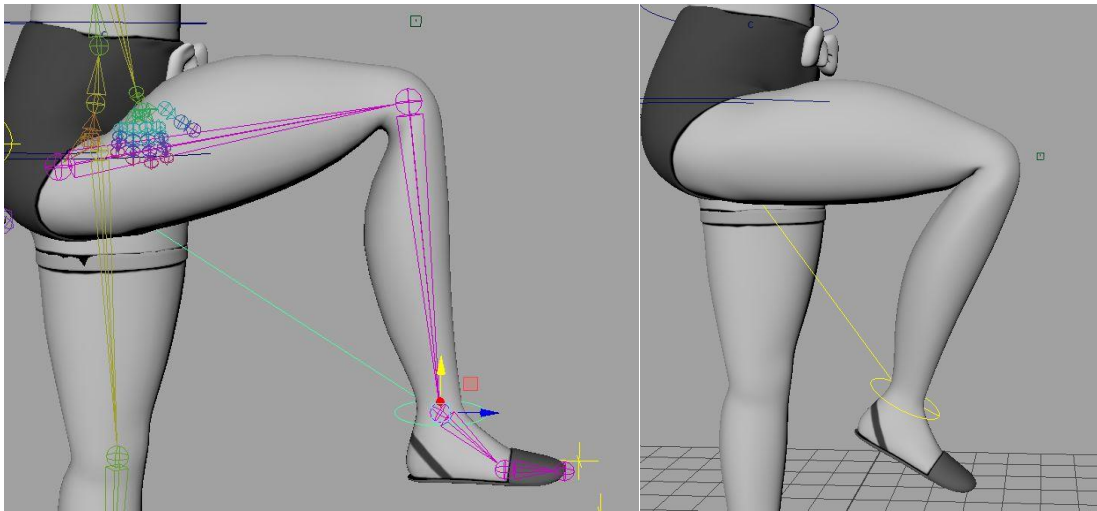
PICTURE 41. Various states of the “controlling mechanism” of the curls.



PICTURE 42. 3D character mesh with finished rig and controllers.

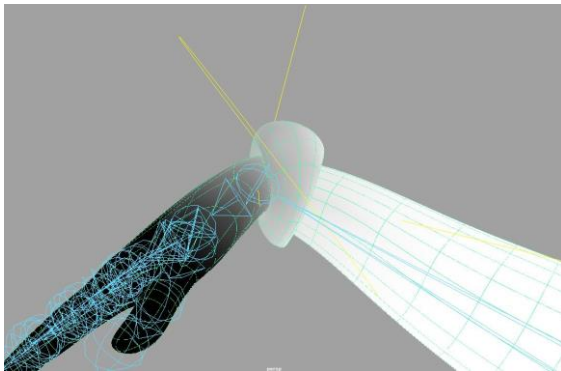
#### 5.4.4 Mesh weight tweaking

The character's rig was attached to the Betty Boop model when every part of the rig was finished. Autodesk Maya automatically applies mesh weights in the attaching process, but weight values had to be tweaked for better representation of human body's softness. Because Betty Boop's head looks dollish and shows only tiny deformations, the body had to compensate with dynamic variations to avoid the impression that the model is an artificial doll (picture 43). Replicating the way how a human body bulges and stretches in certain poses in real life worked as the main reference. Aiming for curvy cartoon forms occasionally overruled those references, because Betty Boop's limbs become exaggeratedly curvy or even "rubbery" in certain poses in the cartoons.



PICTURE 43. Untweaked leg looks plastic in the right picture, but it gained more natural skin and muscle behaviour after weight value tweaking.

The character's apparel and clothes needed some tweaking too to retain their intended shape. Betty Boop's bracelets were a pair of items that had to retain their circular form due to their solid, metallic nature, for example. To express that kind of nature, weight values around the wrist had to be increased so that weights from other bones could not distort the forms of the bracelets (picture 44).

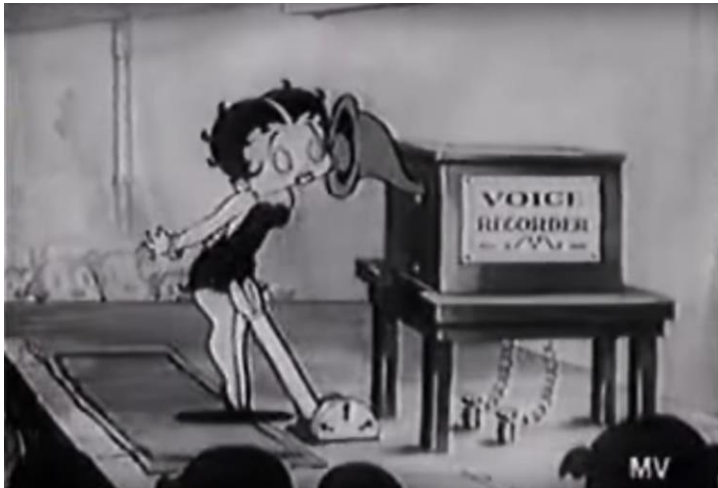


PICTURE 44. Bracelets squeezed unrealistically whenever the hand was moved.

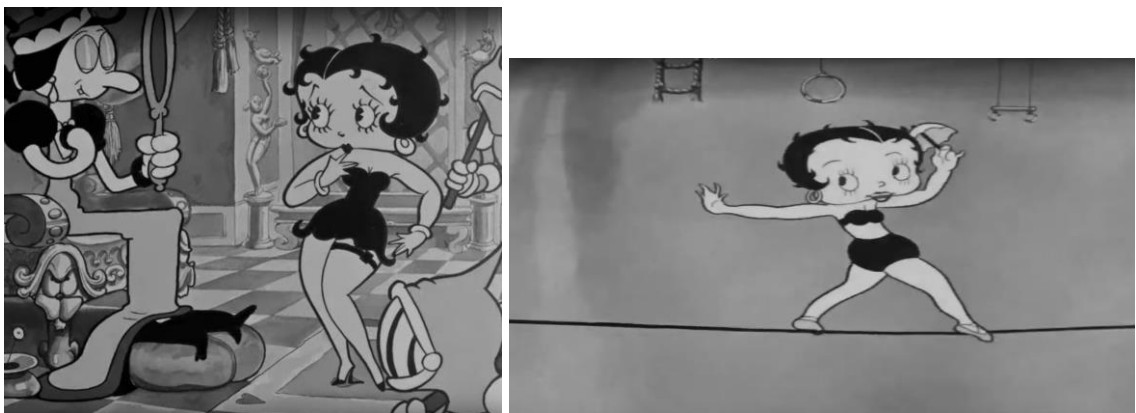
Tweaking mesh weights was the final part of the rigging phase. The complicatedly built rig and weight tweaking made sure the model's poses and silhouette could match their 2D counterparts from the cartoons as closely as possible in the staging phase.

## 5.5 Staging the character

3D Betty Boop's posing capabilities were tested and confirmed in the rigging phase, but it did not give a full image about the character's readability in an actual scene. It meant that a couple of scenes had to be created in the similar grayscale style that the character model possessed. Instead of creating completely fictitious scenes, two scenes from the original cartoons were chosen. A scene where Betty sings next to a voice recorder in an exhibition tent was the first choice (picture 45). The second choice was combined from two scenes: a throne room scene where Betty is feeling insecure, and another scene where she is ropewalking in a circus tent (picture 46). These scenes made the swimming suit of the 3D Betty Boop improve staging already at this point, because the clothes felt appropriate in the chosen settings.



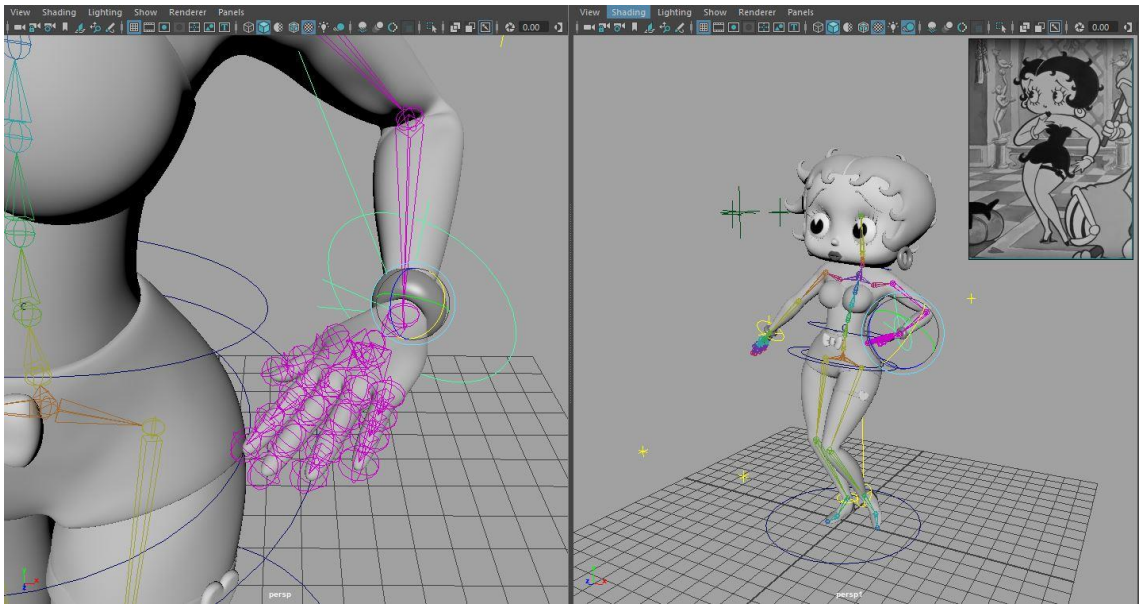
PICTURE 45. A scene of singing Betty Boop.



PICTURE 46. Betty Boop's pose from the left picture was combined with the ropewalking setting from the right picture.



Both scenes had identical workflows and matching the 3D Betty's pose with the cartoon Betty's pose was the first step. It was done with two cameras: one was used for viewing and adjusting the character's pose closely from convenient angles, and the second camera was locked to the same angle that the chosen scene from the cartoon had (picture 47). Small deviations had to be done to the poses at this point too, because Betty Boop's anatomy had inconsistent proportions in the cartoon scenes – most likely because they were picked from different animations and they all depicted the character a bit differently than the self-made character sheet for the 3D model.

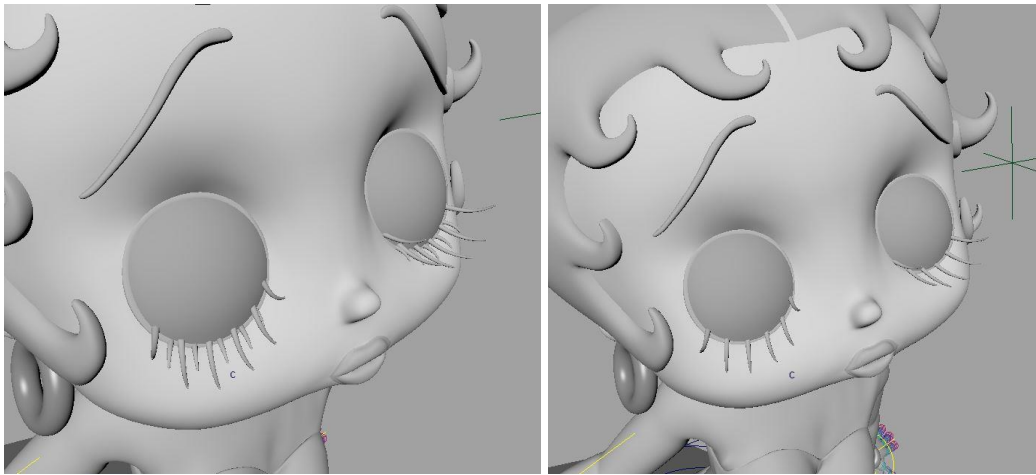


PICTURE 47. Two cameras were used for easier posing and seeing how the pose would look in the final framing of the scene. Screenshot of the cartoon scene was also visible for matching the 3D scene's camera angle with the cartoon scene's camera angle.

### 5.5.1 Improving readability

After the character's main pose was ready, readability of details was improved with small adjustments. Betty Boop's closed eyes caught the attention first in the singing scene, because her eyelashes created a dense clump of details when the upper eyelid was down and its eyelashes were in the same narrow area as the lower eyelid's eyelashes. To improve the clarity of the eyelash area and help them retain the simplified cartoon style, eyelashes of the lower eyelid were hidden (picture 48). There was even a note about the correct number of eyelashes in the original Betty Boop character sheets and it was used as a reference to ensure balance of details.





PICTURE 48. Eyelashes of the upper and lower eyelids are visible in the left picture. Lower eyelid's eyelashes are hidden in the right picture to create clearer appearance for the overlapped eyelash area.

Disabling some of the shadows became necessary too when the eyelashes were adjusted. The selective absence of shadows in certain areas emphasized the contrast of dark and light elements, because the disabled shadows could not soften the contrast with gray values. The shadows of eyebrows, eyelashes, earrings and curls of the hair were disabled for that reason and, additionally, to simplify the shadows that big groups of elements casted on underlying elements. For example, the character's head created a rounder shadow on the shoulder area, because it did not include small shadows that the earrings and curls would had created outside the main shadow's shape. Rounder shadow shapes basically emphasized cartoony feel, since old cartoons often simplify shadows to the point where they only crudely resemble the forms that cast them (picture 49).

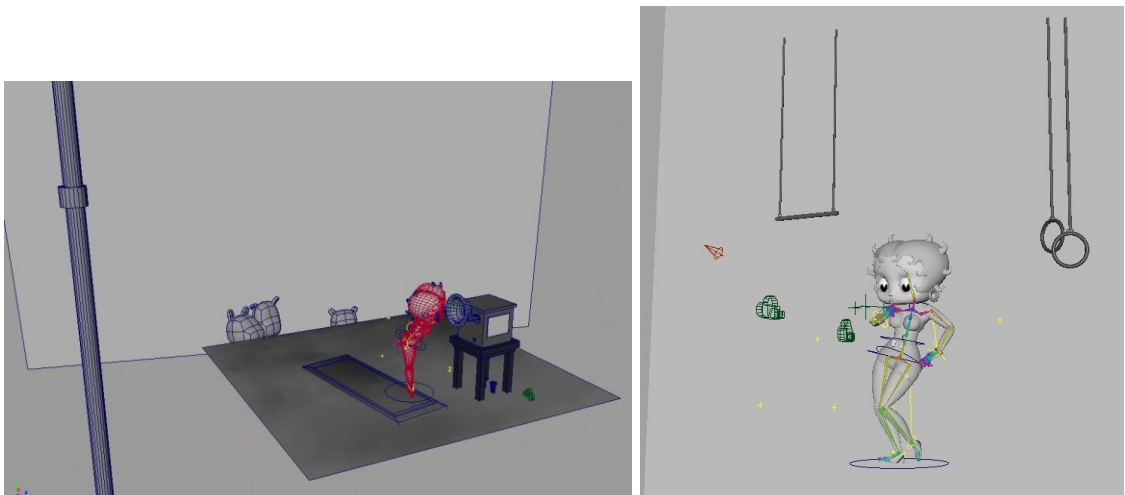


PICTURE 49. Characters' cast shadows sometimes resemble simple dark "blobs". (Dragon Ball Z 1989)

The angle of the hair curls was also adjusted to match their angle and visibility from the cartoons in this stage. One half of the curls was already facing the viewer appropriately, because their angle was linked to the camera that provided the final framing of the scene. The angle of the remaining half had more flexibility, because their angle was attached to a third, unused camera that only worked as their controller. Therefore, the third camera's angle was rotated so that the curls moved to a position that created the iconic silhouette of Betty Boop's hair. If the third camera was left untouched, the remaining curls would have been hidden adversely by the head mesh.

### 5.5.2 Building the setting

Simple props were modelled for the scene's setting, based on the cartoon scenes that were chosen. Instead of accurately modelling their every detail, basic forms were only created so that their visual richness would not compete with the character (picture 50). Additional details were added later to the props with textures and 2D "paint overs" in the post-process stage. Lighting was done with Maya's sky dome light that replicated soft daylight, which is good for mimicking the flat lighting of Betty Boop cartoons, because it does not create sharp cast shadows. The character's head was the main reason for the lighting type, since its big size easily shaded half of the upper body in other lighting types.



PICTURE 50. Scenes with all the props and the character. The green, double cameras of the hair silhouette rig are visible in the editing camera's view.

Tweaking objects' brightness values and material qualities became important when all the props and the character were staged, because the scene was completely grayscale and

essential details had to be easily distinguishable. For example, improving the position of Betty Boop's skin and eyes in the visual hierarchy of the setting was done by making them lighter than most of the props and background details. Similarly, dark values in the environment were brightened a bit to make sure the character's dark elements were the darkest. The outcome resembled the cartoons' style that reserves the strongest values and biggest contrast for important elements and makes not-so-important elements less eye-catching with low contrast and decreased definition.

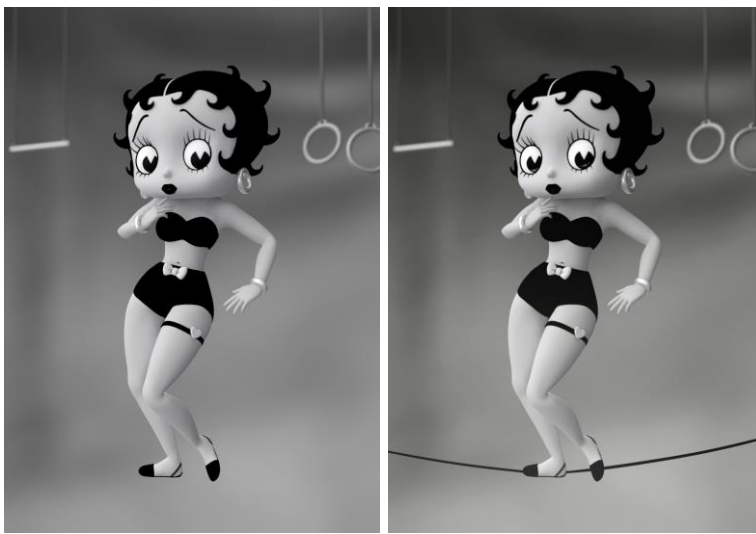
## **5.6 Rendering and final touches**

When all the staging elements were finished, the scene was rendered with Maya's Arnold rendering software. To slightly benefit from the 3D medium's capabilities, depth of field effect was used to make the scene feel more "realistic", because it was not completely rendered in cartoon style, despite the black cel shading effect.

The rendered images were imported to Adobe Photoshop for retouching, since the images were still missing some details or their presentation was inadequate. For example, the audience members were simple, textureless meshes in the singing scene, but they started to match the cartoon scene's look after corresponding details were painted on them with a brush tool (picture 51). Details were similarly added to the voice recorder with a text tool. Because of the black cel shading effect on the character model, the cables and the ropewalking rope were drawn with a solid black brush to spread the cel shading effect even further, making it feel like a justified stylization in the whole scene (pictures 51 & 52). The images' overall contrast was adjusted and specific parts got drawn highlights as the final touch to improve readability of forms and material properties.



PICTURE 51. Comparison of the “Singing Betty Boop” scene before and after retouching.



PICTURE 52. Comparison of the “Ropewalking Betty Boop” scene before and after retouching.

## 5.7 Final result

The final results of the 3D adaptation of Betty Boop look convincing, for it retained the character’s iconic silhouette and cartoony aesthetics from the original cartoons. Those features owed much to the overly complicated rigging mechanisms, whose basic concepts seemed gimmicky in the beginning, but eventually proved to be practical. Readability of forms could use refining however, because the lack of cartoony outlines and the grayscale theme started to blend similar values together in some areas. The black cel shaded elements could be seen as another saviour that worked better than expected when it was combined with realistic shading to conceal technical limitations of the 3D model. To de-

velop the staging further, making the backgrounds more visually interesting could be considered, because they lack the visual richness of the cartoons' backgrounds. In the end, I deemed the outcome successful, final versions of the scenes can be seen below (pictures 53 & 54).



PICTURE 53. Final version of “Ropewalking Betty Boop” scene.



PICTURE 54. Final version of “Singing Betty Boop” scene.

## 6 CONCLUSION

Cartoons can be considered a playful medium that uses various visual tricks to get the creator's most important messages communicated to viewers. Sometimes the communication is handled in a subtle manner as the qualities of cartoon characters' building blocks indicated. In other occasions, the characters do their best to entertain the viewer with imaginative visual cues that cannot be produced in the real world when they exaggerate the purest essence out of a specific subject, whether it is a part of humanity or an abstract feature. And yet, despite their simple appearance, cartoon characters make everything seem credible, because their creators know how to pull the strings that are connected to our own experiences. In contrast to my thoughts before the thesis was started, cartoon characters' distinguishable stylization does not twist or drop the essential information that they should deliver to the audience. They strengthen it by dropping unnecessary parts away so that people cannot miss the main idea of the concept.

The 3D adaptation of Betty Boop proved that abstract qualities of a cartoon character can be transferred to 3D adequately. However, the success depended partly on the 3D model's ability to hide the medium's technical limitations with stylization. The stylized parts were therefore a forced feature in the sense that their absence would have most likely made viewers concentrate on the shortcomings of the mechanisms that controlled abstract elements. The hair silhouette was basically the only risky part of the whole 3D adaptation, but it can certainly work as a base for an updated version that would not have to hide any weaknesses with material properties. Interestingly though, hiding the technical limitations represented the way how cartoons drop irrelevant elements!

A possible update could add more flexibility to the character's other body parts, because the simplified rig of the 3D Betty Boop could not bend her limbs as freely as they did in the cartoons. To be exact, this refers to the rubbery, arc-like shapes that some cartoon characters can make with their arms and legs for example. More flexibly behaving limbs would be better at mimicking the many natures of lines and creating a better illusion of life. Nevertheless, I am content with the capabilities of the 3D Betty Boop, surprisingly to be honest.

As a conclusion, cartoon characters can work and feel the same as they did in 2D when they are moved to 3D. If you overcome the challenges of combining the different qualities and technical limitations of the two mediums, they can work in a fascinating manner and complement each other.



## REFERENCES

22 Words. 12 Ridiculous Road Signs You'll Have To See To Believe! Read 15.11.2018. Online article. <https://twentytwowords.com/12-ridiculous-road-signs-youll-have-to-see-to-believe/>

Artyfactory a. The Visual Elements: The Building Blocks of Composition in Art. Website. Read 27.7.2018. [http://www.artufactories.com/art\\_appreciation/visual-elements/visual-elements.html](http://www.artufactories.com/art_appreciation/visual-elements/visual-elements.html)

Artyfactory b. Line as a Visual Element of Art. Website. Read 27.7.2018 [http://www.artufactories.com/art\\_appreciation/visual-elements/line.html](http://www.artufactories.com/art_appreciation/visual-elements/line.html)

Artyfactory c. Pattern as a Visual Element of Art. Website. Read 31.7.2018 [http://www.artufactories.com/art\\_appreciation/visual-elements/pattern.html](http://www.artufactories.com/art_appreciation/visual-elements/pattern.html)

Betty Boop in Red Hot Mamma. 1934. Direction: Dave Fleischer. Production: Fleischer Studios. Presented 2.2.1934.

Betty Boop's Little Pal. 1934. Direction: Dave Fleischer. Production: Fleischer Studios. Presented 21.9.1934.

Becker, A. 2015. Staging - 12 Principles of Animation. Video. Released 30.1.2015. Watched 26.11.2018. <https://www.youtube.com/watch?v=u-SXLaQGg50>

Berserk. 2016. Direction: Shin Itagaki. Production: GEMBA, Millepensee & Liden Films. Presented 1.7.2016-23.6.2017.

Bradley, S. 2010. Dominance: Creating Focal Points In Your Design. Vanseo Design. Online article. Released 1.2.2010. Read 25.7.2018 <https://vanseodesign.com/web-design/dominance/>.

Caterina. 2017. Abstract Art: Works And Artists. The ArtPost Blog. Blog Post. Released 6.10.2017. Read 20.10.2017. <https://www.theartpostblog.com/en/abstract-art/>

Christensen, E. 2017. 5 Exercises for Drawing with Atmospheric Perspective. Released 19.5.2017. Read 1.6.2018. <https://medium.com/@ConceptsApp/5-exercises-for-drawing-with-atmospheric-perspective-869e2dcfb855>

Cronin, M. 2009. 10 Principles Of Readability And Web Typography. Article. Read 26.11.2018. <https://www.smashingmagazine.com/2009/03/10-principles-for-readable-web-typography/>

Daily Lives of High School Boys. 2012. Direction: Shinji Takamatsu. Production: Sunrise. Presented in Japan 9.1.2012-26.3.2012.

Doucet, R. Drawing and Composition for Visual Storytelling. Blog post. Read 29.11.2018. <http://www.flooby.nooby.com/comp1.html>

Dragon Ball Z. 1989. Direction: Daisuke Nishio. Production: Toei Animation. Presented in Japan 26.4.1989-31.1.1996.

Drunk Salaryman. 2012. Production: The Japan Times. Comic strip. Released: 1.7.2012. [https://www.japantimes.co.jp/opinion/2012/07/01/cartoons/drunk-salaryman/#.XBL\\_1-KYOU1](https://www.japantimes.co.jp/opinion/2012/07/01/cartoons/drunk-salaryman/#.XBL_1-KYOU1)

Eisner, W. 2008. *Graphic Storytelling And Visual Narrative: Principles and Practices from the Legendary Cartoonist*. 1<sup>st</sup> edition. New York: W. W. Norton & Company.

Fingerpori. 2018a. Itä-Savo. Comic strip. Released 27.11.2018. Read 28.11.2018 <https://ita-savo.fi/teemat/fingerpori/ef641b54-4a20-4681-8e83-ab9209c8f1d2>

Fingerpori. 2018b. Helsingin Sanomat. Comic strip. Released 12.11.2018. Read 13.12.2018. <https://www.hs.fi/fingerpori/car-2000005893882.html>

Fingerpori. 2018c. Helsingin Sanomat. Comic strip. Released 3.8.2018. Read 15.9.2018 <https://www.hs.fi/fingerpori/car-2000005777234.html>

Fussell, M. 2010. Line Weight (Quality) and Cross Contour Lines. Website & video. Read 28.8.2018. <https://thevirtualinstructor.com/line-quality-cross-contour.html>

Grais, S. Comics Color. DePaul University, College of Computing and Digital Media. Website. Read 10.12.2018. [http://facweb.cs.depaul.edu/sgrais/comics\\_color.htm?fbclid=IwAR1iGuKTjDV6TvT7ac3owCOwys7w\\_nEpnQx0q9K-K3xIjkaHCm3\\_spcmKgQ](http://facweb.cs.depaul.edu/sgrais/comics_color.htm?fbclid=IwAR1iGuKTjDV6TvT7ac3owCOwys7w_nEpnQx0q9K-K3xIjkaHCm3_spcmKgQ)

Gummerrus Kustannus Oy. 2009. *Symbolit Ja Merkit*. Trans. Häkkinen, C. & Ruuhinen, H. Helsinki: Gummerrus Kustannus Oy. Original work 2008.

Hergé. 1943. *The Adventures of Tintin: The Secret of the Unicorn*. Tournai: Casterman.

Hergé 1947. *The Adventures of Tintin: King Ottokar's Sceptre*, Tournai: Casterman.

Leong, J. 2006. Number of Colors Distinguishable by the Human Eye. Website. Read 14.12.2018. <https://hypertextbook.com/facts/2006/JenniferLeong.shtml>

Lumen Learning. *Elements of Art*. Website. Read 5.7.2018. <https://courses.lumenlearning.com/atd-sac-artappreciation/chapter/oer-1-9/>

Luque, R. 2012. *The Cel Shading Technique*. Dissertation. Read 24.11.2018. [https://raulreyesfinalproject.files.wordpress.com/2012/12/dissertation\\_cell-shading-raul\\_reyes\\_luque.pdf](https://raulreyesfinalproject.files.wordpress.com/2012/12/dissertation_cell-shading-raul_reyes_luque.pdf)

McCloud, S. 1994. *Sarjakuva: Näkymätön Taide*. Trans. Heiskanen, J. Helsinki: The Good Fellows ky. Original work 1993.

McCloud, S. 2006. *Making Comics: Storytelling Secrets of Comics, Manga and Graphic Novels*. 1<sup>st</sup> edition. New York: HarperCollins Publishers.

McDonnell, M. The Importance of a Good Silhouette. Blog post. Read 27.11.2018. <http://theartcenter.blogspot.com/2010/02/importance-of-good-silhouette.html>

- Minnie's Bow-Toons. 2017. Disney Junior. Video. Released 7.9.2017. Watched 2.12.2018.  
[https://www.youtube.com/watch?v=vfZbV2KXbDo&list=PL2m1vjiMH\\_hNYvAAHdLsuB0y7OIva3VSI](https://www.youtube.com/watch?v=vfZbV2KXbDo&list=PL2m1vjiMH_hNYvAAHdLsuB0y7OIva3VSI)
- Motomura, J. Technical artist. 2015. GuiltyGearXrd's Art Style : The X Factor Between 2D and 3D. Keynote presentation. Game Developers Conference 2015. 2-6.3.2015. San Francisco.  
<https://www.youtube.com/watch?v=yhGjCzxJV3E>  
<https://www.youtube.com/watch?v=yhGjCzxJV3E>
- My Hero Academia. 2016. Director: Kenji Nagasaki. Production: Bones. Presented in Japan 3.4.2016-present.
- Naruto. 1999. Written/direction: Masashi Kishimoto. Production: Shueisha. Presented in Japan 21.9.1999-10.11.2014.
- Naruto. 2002. Direction: Hayato Date. Production: Pierrot. Presented in Japan 3.10.2002-8.2.2007.
- Nassau, K. The Perception of Colour. Website. Read 10.12.2018. <https://www.britanica.com/science/color/The-perception-of-colour>
- Oh My Disney. 2016. The 12 Principles of Animation as Illustrated Through Disney And Disney Pixar Films. Website. Read 13.12.2018. <https://ohmy.disney.com/movies/2016/07/20/twelve-principles-animation-disney/>
- One Piece. 1997. Written/direction: Eiichiro Oda. Production: Shueisha. Presented in Japan 22.7.1997-present.
- One Piece. 1999. Direction: Kōnosuke Uda, Junji Shimizu, Munehisa Sakai, Hiroaki Miyamoto, Toshinori Fukazawa, Satoshi Itō, Tatsuya Nagamine. Production: Toei Animation Co. Ltd. Presented in Japan 20.10.1999-present.
- Pancare, R. 2018. How Do Bright Colors Appeal to Kids? Article. Read 24.7.2018. <https://sciencing.com/do-bright-colors-appeal-kids-5476948.html>
- Pantelić, K. 2016. Exploring the Form in Art. Website. Released 10.12.2006. Read 25.11.2018 <https://www.widewalls.ch/form-in-art/>
- Panty & Stocking with Garterbelt. 2010. Direction: Hiroyuki Imaishi. Production: Gainax, Presented in Japan 1.10.2010-28.4.2011.
- Pellot. The Scandalous Story Behind The Real Betty Boop Will Blow You Away. Little Things. Online article. Read 9.8.2018. [https://www.littlethings.com/real-betty-boop-baby-esther?utm\\_medium=google&vpage=3](https://www.littlethings.com/real-betty-boop-baby-esther?utm_medium=google&vpage=3)
- Prokopenko, S. 2012. Shading Light And Form – Basics. Website. Released 8.11.2012. Read 25.11.2018 [https://www.proko.com/shading-light-and-form-basics/#.W\\_sBxOKYOUk](https://www.proko.com/shading-light-and-form-basics/#.W_sBxOKYOUk)

Sabbagh, M. 2015. Out of Character: How to Design Good Game Characters. Article. Read 15.6.2018. [https://www.gamasutra.com/blogs/MichelSabbagh/20150825/252065/Out of Character how to design good game characters.php](https://www.gamasutra.com/blogs/MichelSabbagh/20150825/252065/Out_of_Character_how_to_design_good_game_characters.php)

Salgood, S. 2015. Line Weight: When to Vary It and Why? Video. Watched 9.8.2018. <https://www.youtube.com/watch?v=MldkhPOf10o>

Schodt, F. 1983. Manga! Manga! The World of Japanese Comics. 1<sup>st</sup> edition. Tokyo: Kodansha International Ltd.

Schwarz, R. 2013. 10 Creepy Examples of the Uncanny Valley. Article. Released 25.11.2013. Read 14.12.2018. <https://www.strangerdimensions.com/2013/11/25/10-creepy-examples-uncanny-valley/>

Starr, M. 2017. Your Eyes Are Liars: These Strawberries Aren't Red. Website. Read 10.12.2018. [https://www.cnet.com/news/your-eyes-are-liars-these-strawberries-arent-red/?fbclid=IwAR3iwQ6FEglwhcHUdbNmHXeOU2RIHxXR8CAZiq5ROj\\_D0Izsef-ndm3i3tSw](https://www.cnet.com/news/your-eyes-are-liars-these-strawberries-arent-red/?fbclid=IwAR3iwQ6FEglwhcHUdbNmHXeOU2RIHxXR8CAZiq5ROj_D0Izsef-ndm3i3tSw)

Tainted Love. 2001. Artist: Marilyn Manson. Direction: Philip G. Atwell. Production: Interscope Records. Presented in USA 21.11.2001.

Tales from Weirldland. 2017. Blog post. Read 26.11.2018. <http://talesfrom-weirldland.blogspot.com/2017/04/betty-boop-model-sheets-mouth-chart-and.html>

Tate a. Gestural. Website. London: Tate Gallery. Read 21.10.2018. <https://www.tate.org.uk/art/art-terms/g/gestural>

Tate b. Abstract Art. Website. London: Tate Gallery. Read 8.10.2018. <https://www.tate.org.uk/art/art-terms/a/abstract-art>

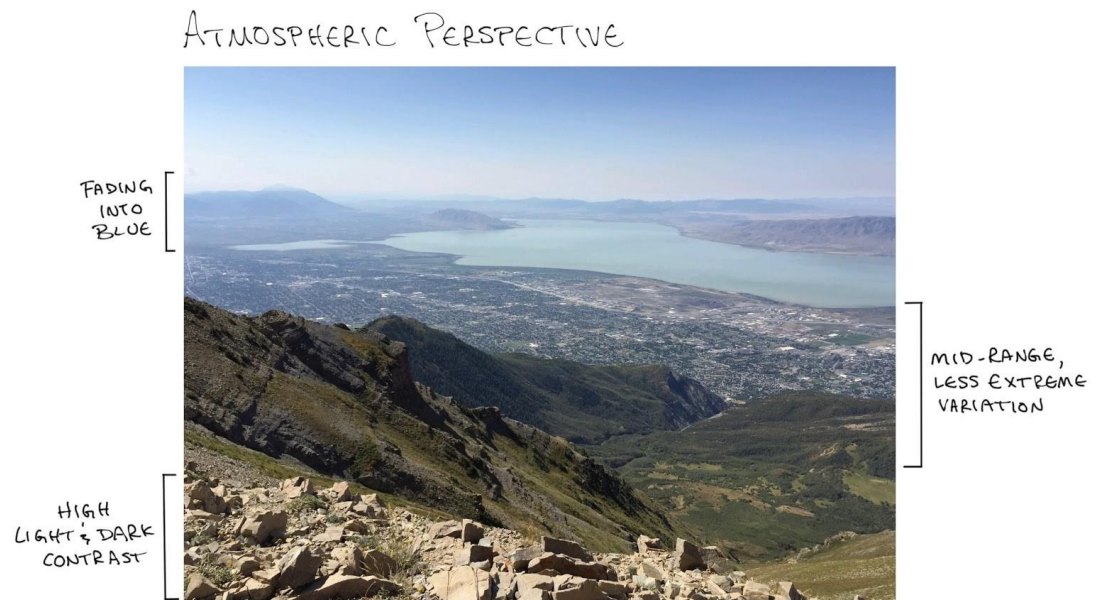
Teguh, T. 2018. Character Design: Shape Language and Readability. Released 26.4.2018. Read 10.6.2018. <https://80.lv/articles/character-design-shape-language-and-readability/>

Valve. 2017. Dota 2 Workshop - Character Art Guide. Online Guide. Read 16.6.2018. <https://support.steampowered.com/kb/9334-YDXV-8590/dota-2-workshop-character-art-guide?l=spanish#gradient>

## APPENDICES

### Appendix 1. Effects of atmospheric perspective (Christensen 2017)

Contrast variation based on distance:



Focus variation based on distance:





## Appendix 2. Effects of atmospheric perspective (Christensen 2017)

Color variation based on distance:

## COLOR PERSPECTIVE



Appendix 3. Original Betty Boop character sheet A (Fleischer Studios)

## BETTY BOOP

FRONT      SIDE (WRONG)      SIDE

WHEN A SIDE VIEW OF BETTY IS USED, DO NOT CUT DOWN ON THE BULK OF THE BODY-TREAT BETTY'S FIGURE AS A CYLINDER.

NO CURLS ON BETTY'S FOREHEAD.

SHORT DISTANCE BETWEEN UPPER LIP AND NOSE FOR CUTENESS.	NOSE JUST BELOW BOTTOM OF EYES.
EYES ABOUT AN EYE APART.	EYEBROWS ARCH WITH SHAPE OF HEAD TO GIVE ROUNDNESS.
CHEEK-LINE CURVES UP AT MOUTH.	DRAW HIGHLIGHTS IN EYES CAREFULLY; THEY HELP GIVE DIRECTION IN CLOSE-UPS.
IN REAR VIEW, SLIGHTLY REDUCE HEAD SIZE.	AVOID PROFILE, AS IT IS ALMOST IMPOSSIBLE TO MAKE, AND DOES NOT FLATTER BETTY.

~~ELIMINATE PART: USE LINE FOR CONSTRUCTION ONLY.~~

## Appendix 4. Original Betty Boop character sheet B (Fleischer Studios)

