



**Marshall Plan Scholarship Research Paper**

# **„Animations in documentaries – scientific or entertaining?“**

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**Abstract:**

Computer animated sequences in documentaries appear more and more. We are used to the documentary genre that we can believe what we see. But how is that behaving with images which are created by a computer? Can we trust the creators of the documentaries that all we see is researched well? Or has the documentary genre changed to a simply entertaining format. What should a 3D animation in a documentary look like and which rules in designing these should be followed? – If there are any. More often we can see animated creatures in real environment up from atomic size until dinosaurs or watch sports events on big which are documented on big screens in real time. This paper deals with the question of which different types of animation can be seen in documentaries and what specific attributes are important for its specific genre. Also some basic design principles and physical restrictions are considered.

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## 1. Introduction

3D animations nowadays are used in nearly every documentary movie. They are suitable to explain complex relationships, for example in the field of nature, in an easy and understandable way. However, the usage of 3D animations in documentary movies has to be earmarked. They should be close to reality and at the same time not confusing the audience. If we watch documentaries we believe that everything is researched thoroughly, but if we look at other movie genres we can see that every movie purchases its attention through special stories and events. According to this fact the question occurs: is everything real and true what we watch in a documentary? Is everything realistic and well researched? Especially in the field of animations there is a wide range between realism and entertainment. Also animations occur in a wide variety of documentary genres. From simple abstract looking robots to real life animations in animal documentaries. The question is: Which quality is necessary and why is the solution chosen as it is? This paper only looks at 3D animations in the documentary genre because in this genre logically the most important part is the content and not the looking due to the fact that we are dealing with a scientific topic and in science interested audience.

This paper also wants to do some research on the question: What are the Key Features of a 3D animation to make it understandable and how can these features be connected to an artistic design? What is the best picture language to make 3D animations understandable and nice looking? Which shaders, renderers and interfaces are used most and if is it possible to create guiding principles to design functional and amazing looking 3D animations which transport true information. This part is placed at the end of the first part.

The following part gives an overview of the different fields of use for the different types of animations. Because there is no clear defined structure of how animations are sorted, I tried my best and sorted it my own way to get the best diversity of all fields of use. Also there is the problem of 2D, 2.5D and real 3D animations. This paper tries to find and analyze real 3D animations. Also 2.5 or 2D animations which were created by 3D animation software will be left aside. After explaining the main fields of use of 3D animations in documentaries some attributes of animations for this genre are made which lead to the next chapter.

## **2. Definition of documentary**

Documentary films constitute a broad category of nonfictional motion pictures intended to document some aspect of reality, primarily for the purposes of instruction or maintaining a historical record. <sup>1</sup> Further on in this paper the long term documentary films will be shorted to documentaries.

## **3. Animations in documentaries and genres**

### **3.1 3D animations in documentaries - fields of use**

Where can we see computer animated sequences in documentaries and which different types are there? This chapter lists the mayor types of use for 3D animations in documentary movies. These different types outcome by their fields of use and different specific benefits for documentaries.

#### **3.1.1 Nature documentation, explaining and visualizing natural behavior**

This type of animation is defined by their real looking renderings. In this category

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<sup>1</sup> <http://www.oed.com> last visited 30.01.12

a realistic look is desired and they are applied when it is not possible to create such images of the nature or, and that's more and more, the production costs are too low so footage which is hard to shoot will simply be replaced by computer animations. Because the computer renderings are getting better and better every time – the audience nowadays is often not possible to recognize a difference between computer generated images and real shot images. Also things that cannot be shot in real life because of physical restrictions depend to that genre. Until some years it was not possible to create such realistic looking images but with the appearance of global illumination and final gathering techniques the 3D artists were enabled to create lighted scenes and more realistic looking shaders. The first renderable global illumination integration in the most popular renderer was in 1995 in the renderer "renderman"<sup>2</sup>. Since then the quality of the rendered images made a huge step in the direction of realism. Today it's in comparison to earlier times much more easy to create global illuminated scenes and it's a lot faster to render these out.

Because the renderings get more realistic all the time another problem occurs. There is always the question – Is this scene or this picture I see now real? Or is it generated by a computer? Does the producer of the documentary reference every computer generated image? Where is the borderline between showing computer generated images without referencing and which images are definitely cognized as generated by a computer? That leads to the question of the quality of a documentary when it uses computer generated images as real images and the question of the definition of documentary films and as though if it is acceptable.

One mayor part of the type of animations is the visualizing of moving images in outer space. Moving sequences of outer appear in many documentaries and for our perception we believe they are real. But the camera sequences flying from one planet to another are just computer generated images. There is no guarantee that the dimensions of the planets are correct or the planets look like the same in

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<sup>2</sup> <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.50.6422> last visited 30.01.12

real. It depends to the producer of the documentary which grade of scientific correctness is in the animation.

Important issues in that type are:

- **Look and integration in other video footage**

Fits the generated material to the rest of the film? It's important that the 3D animation enables a fluid watching experience.

- **Scientific accuracy**

Is there enough correct data to create an animation or simulation of the topic that stands a scientific approach? And is such a topic presentable close to reality?

- **Shaders, lightening and rendering**

Which shaders should be used? What lightning technique is appropriate? And what type of rendering is necessary? These tree questions are very important for the look of the animation and define the whole design of the animation. To gain the designated realism nearly every animation is lighted and rendered by global illumination and/or final gathering.





**Picture 1: computer generated whales in a documentary film**

Picture one shows two images of a computer generated whale in a documentary. The look and the movement of the whale is very fluid and realistic. Also the water and the whole environment make us believe that this is a real whale.



**Picture 2: Image of a real whale**

Picture 2 shows us an image of a real whale. There is not a real difference in the look of the two images (Picture 1 and 2). If the photographer or the 3D artist would have used just a little different adjustments by taking the picture, they



could look exactly the same.

### **3.1.2 sports documentation, visualizing actions, explaining live actions**

Sports animation should give the viewer a better insight in the processes which are going on in real time. So this kind of animation normally has to be very fast created and also must be very accurate because sport events are dealing always with very accurate units like microseconds or millimeters. So there occur two mayor problems in the field of animations in sports events. The first one is the problem of the lack of time. Every computer generated image needs time to be rendered. And for fast reviews there is no time. The same problem occurs for live visualizations for video-walls or live transmissions. In some parts animations can be prepared before the event, like for football games, but in other cases it's not predictable which animation is needed. I found a very well example of an animation or better a whole animation system at the Americas cup racings in San Diego. The Americas cup was founded in 1851<sup>3</sup> and so it is one of the oldest racings in history and they put a lot of new inventions and techniques in every years season and not only in the ships, also in the way that they transport the racings from the not really good watchable seas and harbors to the audience at the piers and coasts who are trying to watch that special event.

So such an event needs a very fast created animation – but the urge to style and design is very high in such high cost events and so the hosts want to show that specialty in good quality. Good quality is achieved by a high resolution and by the use of a good and realistic renderer. To achieve a good render, many polygons, or even nurbs-surfaces, have to be used. Also textures in high resolutions are required. And top of the renderer hill would be a multi-pass rendering and a subsequent compositing. For all that a whole rendering farm would be needed but on a live situation it's not possible to allocate all that. That leads us to the next

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<sup>3</sup> <http://www.americascup.com/en/Discover/A-brief-history/> last visited 11.01.12

problem in sports documentaries. The lack of rendering power. Such a project has to be rendered on a single workstation or even on a laptop and that affects the quality of the render extensively. Although the required speed of the rendering just allows GPU rendering like it is done in computer games. It's possible to do multi-pass renderings on GPUs but it slows down the system heavily.

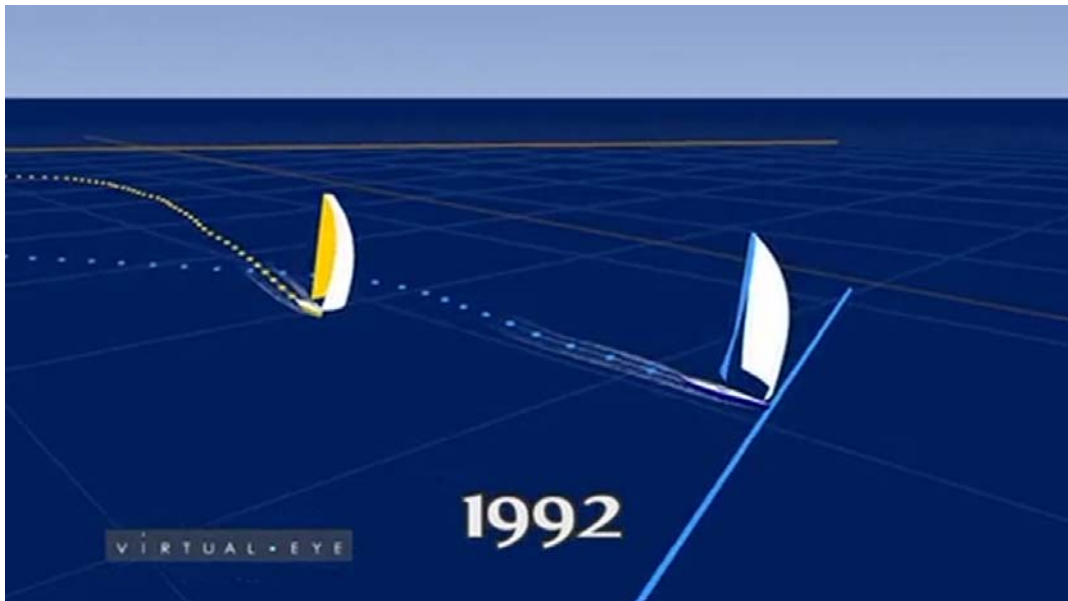
The next problem in animations in sports documentaries is the need of accuracy. This affects both, the temporal and the geographical aspect because sometimes millimeters decide of winning or losing a race and the audience wants to see the real data – and that in high definition. So this accuracy is very hard to achieve and also slows down a system.

My example of the Americas cup has to deal with all that problems. The animations they make are spread around the world and on video-walls in real time. The Americas Cup is a high budget event and so the animations have to be very stylistic. Also the races are fast and the ships make a lot of track. Although they drive long distances at the finish they are most very close together. The races taking place at the sea, that's also a problem for technical equipment and because often the race track isn't very visible the animation and the live video transmission has a high local value.

The company which makes the visualizations for the Americas Cup does that since 1991<sup>4</sup> and increased the quality every year.

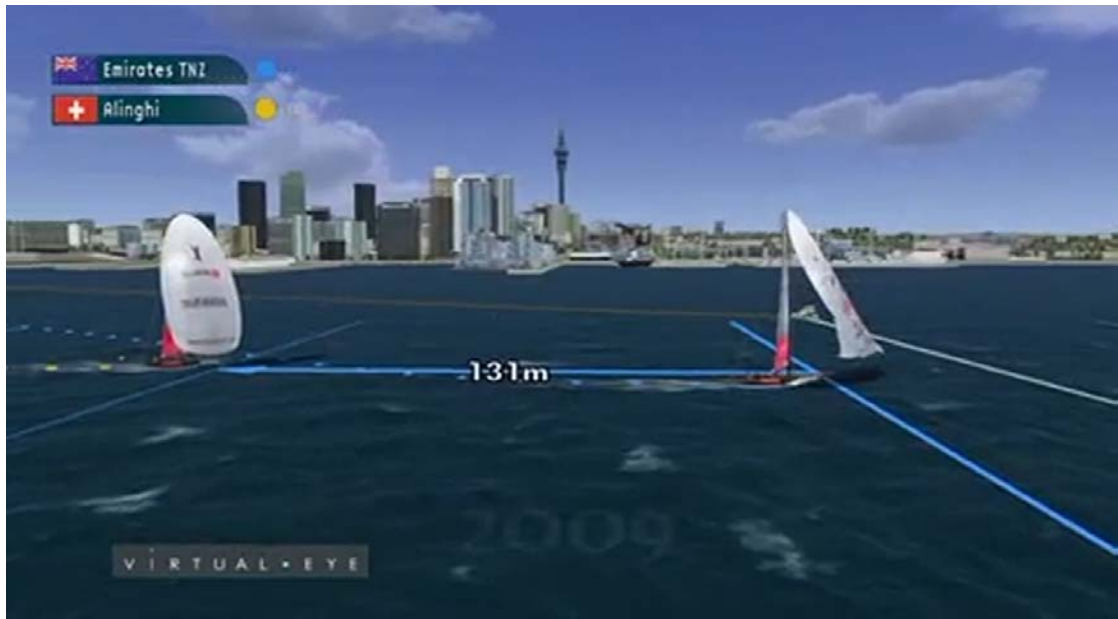
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<sup>4</sup> <http://arl.co.nz/index.php/arl-company/arl-history> last visited 11.01.12



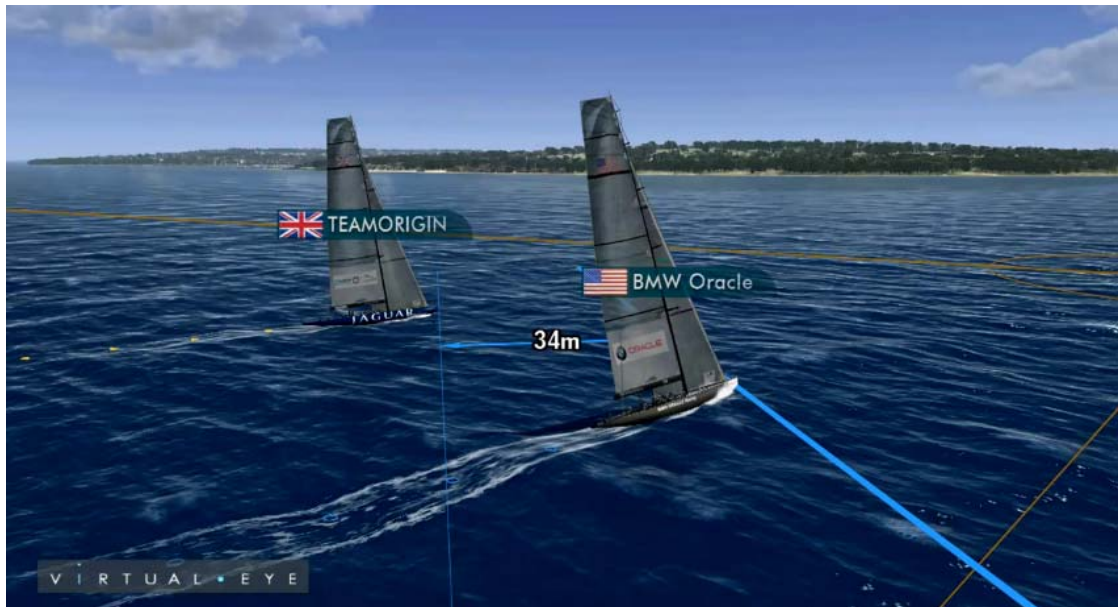
**Picture 3: Visualizing software “virtual eye” for Americas Cup in 1992**

In Picture 3 the render of the software “Virtual Eye” from the 3D-Studio “Animation Research LTD” is shown. It’s a very simple render, but it’s in real time and it’s 1992. There are just the ships “pulled” through a very simple 3D space. In 1995 virtual eye uses textures for the ships which gives the ships a unique look. To the year 2000 textures at the water are added and also the texture quality of the ships was increased. The polygons of the ships were increased too. In 2003 the environment was added to create a better impression of the whole image and by the use of transparency of the sails the quality was increased again.



**Picture 4: Render of the software "Virtual Eye" in 2009**

Until 2009 the quality of the render changed dramatically. In 2009 multiple textures, interactivity in the animation, animated sails and ships, a whole new environment fluid animation and the sky were added. Until 2011 the look of the animation has become even better.



**Picture 5: Live Render of the Software "Virtual Eye" at the Americas Cup 2011**

In a nutshell the main problem of this genre is always the limited render time which is in the best conditions no time at all. Also the need of exact data and the

subsequently following exact animation causes problems. These problems always decrease the style quality – if it should look realistic.

### **3.1.3 historical/ futuristic imaging – visualizing not physical present**

This type of 3D animations shows historical circumstances or the environment of the future. Typical for this type is that often there is the need of a huge environment, for example whole historical towns. This kind of animations should look as realistic as possible which becomes very difficult by creating environments which nobody has ever seen. This is also the area where the renderer is the most important factor. He enables photorealistic renderings that give the audience a realistic and clear image of things, places, or actions. Beside the renderer the animation of motions (if there are any) is also very important. These animations should give the impression of realistic images and the goal is to create an image that looks real for the audience and is believable although it does not exist. This is the youngest type of animations which is used in documentaries because of the fact that until some years ago it was simply not possible to create realistic looking computer generated images with the budget of documentaries.

The breakthrough in creating such type of images was not in documentaries it was in the movie "Jurassic Park" in 1993<sup>5</sup>. This film is famous for its realistic looking dinosaurs.

Normally the budgets for documentaries are much smaller than the ones for fictional films and that can be seen in the quality of its 3D animations.

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<sup>5</sup> <http://www.imdb.com/title/tt0107290/> last visited 11.01.12

### 3.1.4 metaphoric animation – visualizing procedures, correlations

This type of animation explains scientific correlations and processes. The focus is not at the most photorealistic display, but its goal is to explain and display complex correlations in the easiest way possible. The shown images should help to explain scientific processes as good as possible.

These goals create new problems. The problem of the long render time and connected to that the quality is just a bit part. The mayor problem is the design of the coherent correlations at the screen. One area of these animations would be the display of processes on atomic level or other not invisible levels.



**Picture 6: 3D generated image of a human heart**

Picture 6 shows an example of this type of 3D animations. The heart and the chest wouldn't be seen in such a way in real life, but this illustration shows a metaphor of the real circumstances. Some bones have been removed to enable the view at the heart and also other things that else would block the view. Nobody can guarantee that the proportions of the shown things are correct, this

is most of the time the decision and the liability of the designer.

The creator of such an animation can exaggerate or trivialize it, or he tries to make it as authentic as possible.



**Picture 7: animation of the documentary "when the moon disappears"**

Picture 7 shows a animation of the documentary „when the moon disappears“.

This animation shows us the deformation of the earth that is caused by the moon. It's displayed in a much exaggerated way because else it wouldn't be possible to see such a deformation.

## **3.2 definition of attributes in 3D animations**

### **3.2.1 design aspects**

In the field of 3D animations there are a lot more possibilities than in creating motion pictures with cameras or by painting. These wider ranges of possibilities need some basic rules to create an effective animation. Rules of perception which are used in usual films are important as the rules from common painted animation techniques. This chapter gives a summary of these.

First of all there is always the discussion of the look of a film. The look of a film

describes the soft and the flat images which are created by chemical composition of the film – its grain.<sup>6</sup> 3D created images do not have any grain because the computer creates clear high contrast images with no natural blur or grain. So the Look has to be added in a further production step to make the material look realistic and fits to the other material. Are the 3D generated images perfectly fitted to the rest of the movie the whole visual perception normally leads to a better impression and smoother transitions between real and computer generated images. The whole film is composited out of many different components like image composition, coloring, contrasts, perspective, angle of vision, light costumes, characters and narration rhythm. All these tools to create a specific style can be used to support the narrative of the story.

## **Composition**

Image composition is a essential aspect to lead the view of the audience. At the film media this is a lot more important issue than at conventional paintings, pictures or illustrations because the creator is restricted in the time in which he can lead the audience through a composition. This pressure of time demands economical balance in details and confusing arrangements. Like so often the rule of “keep it simple” should be followed. However a lot of the design principles in compositions of still media is important as has to be considered in creating 3D animations.

A very important issue in the aspect of image composition is the use of the camera. The usage of camera movements, depth of field and shutter angles has to be planned very well to create an authentic scene. In comparison to basic animation and filmed sequences, in 3D created environments no restrictions to the camera apply. It’s possible to create every angle or movement and this wide range of possibilities have to be handled very carefully. Like Ed Ghertner it

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<sup>6</sup> Der Passende Look zur Story, Olea, 2011, P. 18



describes: "Artist often move the camera too much. In most cases a little goes a long way, too much can ruin good dynamic action."<sup>7</sup>. This says that the camera movements in 3D animations should be comparable to the movements of real cameras. They shouldn't be too fast or dramatic because the audience is not used to such dramatic movements and will get distracted from the content.

## **Recording format**

The recording format is very important in the consideration of the arrangement in the scene. The first real recording format was created by Kodak which is 3:4. There do exist some more like Cinemascope in 1:2 or Panavision in 1:2.35 but the most used format in TV is 16:9. By using the 3:4 format it has to be considered that two objects have to be much closer together than in the other formats. Also because of the restricted width of the screen it has to be considered to make panning shots for landscape impression which is probably not necessary in the other formats.

## **Focal length and shots**

The focal length is always very important when considering the psychological aspect of the composition. Different focal lengths and lenses create different impressions of the same view. A short focal length which is in the area of a wide angle lens creates a very perspective and dramatic look. Objects appear closer together and parallel edges don't look parallel at all anymore.

Lenses with a focal length of about 50mm look pretty like our natural field of view. These lenses create a very usual, normal and well known natural image. These lenses are used for most of the shots in which there are no special emotional feelings which has to be emphasized.

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<sup>7</sup> Ghertner, Ed (2010): Layout and Composition for Animation. o. O.: Focal Press. P. 126

The third section of lenses is the area of tele-lenses. These are lenses with a focal length of more than 70mm which are also called zoom lenses. These lenses create a very intimate and close look and are most used for emotional scenes.

### **Depth of field and focus**

By composing in depth of field and focus parts it's possible to create a more authentic look because the real lenses always create some depth of field because of the physical restrictions which apply. The audience' view can be controlled by focusing at different areas in the composition and in the offset in depth.

### **Staging and arrangement**

In a medial environment like in a 3D animation it is as important as in a normal film that the stage setting and the stage itself is planned carefully. Normally the space in which the 3D animation is suited does not exist so the space has to be planned very detailed that it fulfills its function. Every prop which is in the scene should have its function and props which do not have a function should not appear in the scene. Furthermore it's important for the workload of the scene which props are really needed because every prop has to be modeled textured and rendered and that increases the production time and costs. Every polygon more increases the render time of the scene, especially if the animation is rendered with photo realistic methods like final gathering or global illumination.

### **Editing**

One very important area in designing 3D animations is the editing part. Normally in 3D animations just the really used material gets rendered because of time and cost issues. But sometimes it's hard to decide with pre-renderings which parts are necessary to make the whole animated sequence work out well. So there has to

be a real good and careful planned edit when a 3D animation is created. One characteristic number in the editing section is the Average Shot Length (ASL). This number indicates the average duration of a shot in a sequence. In the early times of movies the ASL has been much longer than now. For example in the film "Pickpocket" from the director in 1959 the ASL is 10 Seconds<sup>8</sup>. Nowadays some productions have ASL's of 2 seconds or less, like in "The Bourne Ultimatum" by Paul Greengrass from 2007<sup>9</sup>. This film is five times faster cut than a film about 70 years ago. So this issue makes a production of a 3D animation also more complicated. To fit in to the rest of the media from the documentary, the 3D animation should have the same ASL like the rest. A higher ASL means more different shots and this leads to a higher effort in creating the 3D animation. Such issues can let explode the costs of a production very fast if they are not planned well.

## Light

Light arrangement has always been a very important issue in film production. Setting up contrasts, creating focal points and the generation of a native environment is the base of a complete department in the film industries. Creating light art is dealing with light and shadows as elements in film production. Everyone who experiences creating films has less problems with the light than with the shadows.<sup>10</sup>

Due to the fact that in 3D animation Programs nearly everything is possible, the issue of lightning is very important. A 3D animation program is like an ideal studio set. There is no background light and every light source can be placed exactly where it should appear. It's possible to make the light source invisible and it's even possible to create negative light. That means that too bright areas in a composition will get darker if they got lit by a negative light source. That's a very

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<sup>8</sup> <http://unspokencinema.blogspot.com/2007/01/average-shot-length.html> last visited 23.01.12

<sup>9</sup> <http://www.imdb.com/title/tt0440963/> last visited 23.01.12

<sup>10</sup> Die Chinesische Sonne scheint immer von unten, Dunker, 2007, p 17,

common technique to define shadows. Lights must not be physical correct so they can be very strong although they have no physical size and they can also have any color which is possible to create. So that enables a playground of huge area of possibilities in which light carries a very important role in the animation.

One mayor consideration in lightning 3D animation is the issue of creating a light setting with the help of global illumination and final gathering or just with basic lighting techniques. Final gathering and global illumination enables photorealistic renderings to the cost of the render speed. So with actual workstations it's currently not possible to render GI and/or FG settings in real time. So for live transmissions it's not possible. But for all other animations it creates a very realistic look and if it is set up correctly it's fast to work with than basic lighting setups. Simply the render need much more time.

## **Color**

Hitchcock said about himself that he loves color in movies, although he create his master piece "Psycho" in black and white so he mustn't show the red blood in the shower at the murder scene.<sup>11</sup> Color has so many different values that have to be considered. A red is never the same red when it's values have changed just a little. A small change in the value changes the whole meaning of a color. For example a light dark red that goes a little bit too brown is very harmful; maybe it means Christmas and warm feelings, and the same saturation with just a little less brown part in the red changes the color to a signal color which means death blood and caution.

With color it's easy to channel the audience' view. A very good example for that is the film "Sin City" (2003, Miller, Rodrigues, Tarantino). This movie is shot in color than processed to black and white and just a few props, the focal points are left in color.

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<sup>11</sup> Truffout 2003 p. 326



**Picture 8: Screenshot of the film "Sin City" from 2003**

In picture 8 the audience' view is controlled by color. The only thing in the whole image that contains color is the red dress so the audience is completely attracted by this point of color.

In the field of documentaries there are two major aspects where the use of color differs from each other. On the one side there are the animations which should look like real and the colors should appear as they do in real life, and on the other hand there is the function of creating focal points for the audience to explain things easier and to help to orient oneself at the shown picture.

### **3.2.2. Scientific restrictions**

Although 3D animations are created on computers and computers are completely exact, it's a lot of work to create 3D animations which are correct and exact. So in the early times of 3D animations there were no feet shown in the little movies. That was because the feet of the characters often dipped into the bottom or things could not be grabbed by their hands because of the inaccuracy of the 3D program. Today the problem is still here but there are many different techniques to avoid such mistakes in animations. But the workflows also need more time and computing power.

On the other hand it's possible to create extreme exact results, just because of the fact that we are dealing with computers. For animations in the sports area this is necessary because there, some microseconds or millimeters decide in winning or losing a challenge. These animations, like at the Americas cup, are created to be exact and the main focus lies at displaying the results and the actual values as correct as possible and that put the look of the animation at the second place.

#### 4. Conclusion

There is a wide range of use of 3D animations in documentaries and with that many different requirements. In most cases the issue of the render time defines the quality of the animations and this issue is just a temporary one. In a few years render methods and computers will be faster and that will increase the quality of the animations in all areas. It is hard to say if animations in documentaries are entertaining or scientific because they are both. It depends in which context they appear. If you look at the average animation I would say they are more at the entertaining side because a documentary has to be entertaining – else not much people would watch it. So the creators are forced to create entertaining animations. Often there is no other way as to be entertaining and less scientific because there are shown circumstances which would be not visible if the animation would be completely native and not exaggerated. So it is always a tightrope walk for animation designers, they need a very good feeling for the format which are they producing and also for the audience who will watch it. They have always ask themselves the question of what is the best way to transport the information I want to communicate and which grade of entertaining is scientific passable. Also the standard of the documentary accounts to the scientific level of the animations. If the documentary should reach a wide range audience, the animations are more entertaining than in documentaries for marked off audience.

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