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Klaus: A study on the Application of Light and Shadow Based on Gestalt Psychology

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Abstract: *Klaus, as a 2D animation with a 3D effect, uses light and shadow to the extreme. This paper takes the "2D shift 3D" art style of Klaus as the research object, combines the theory of "three-dimensional space created by light" in Gestalt psychology, firstly analyzes the light and shadow performance characteristics of traditional 2D animation: the simple presentation of light sources and Firstly, we analyze the characteristics of light and shadow in traditional 2D animation: the simple presentation of natural light and the application of single light source, then we introduce the factors of light affecting the composition of 3D space: luminance gradient and multiple light sources, and analyze them with the art design of Klaus. Finally, we conclude that the application of luminance gradient and multiple light sources in light is the key to rendering 3D effects in 2d images.*

Keywords: *Gestalt Psychology, Light and Shadow, 2D Animation, 3D Space*

1. The Traditional two-dimensional Animation of Light and Shadow Performance Characteristics

1.1. Simple Presentation of Light and Shadow

2D animation has a long history, and like other traditional arts, 2D animation is also in constant pursuit of realistic aesthetics. However, limited by the production process, the visual presentation of 2D animation can only exist in the form of flat lines and surfaces for nearly a hundred years after its birth, and its effect of pursuing the real 3D space view can only rely on the animator's hand-drawn sense of volume of the form. In 1985, Disney's live-action and animation comedy film Who Framed Roger Rabbit entered the animation production stage, the film's animation director Richard Williams pioneered the use of three transparent layers: the first layer of drawing traditional single line and color; the second layer draws the black and white areas affected by the interactive fusion of 2D animation and 3D animation [1]; the third layer draws the highlights such a composite overlay method so that the 2D animation in the film to a certain extent presents the visual effect of 3D, but when combined with the live-action images, the shadow of 2D animation can still be seen (Figure 1).

Figure 1: Who framed Roger Rabbit

Technically, 2D animation has evolved from early celluloid drawing to the current software drawing. Early celluloid animation is also called "celluloid animation", and for a long time, it was almost synonymous with hand-drawn animation. Celluloid films usually had clear line strokes, large color blocks, sharp shadows and other visual characteristics. Later, with the growing animation industry in

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various countries, this coloring style gradually evolved into the mainstream style of 2D animation. In the twenty-first century, digital painting emerged, and traditional celluloid film painting was gradually eliminated by the times, but the drawing style with celluloid characteristics was retained, and the mode of base color-shadow-highlight was still continued in the production of 2D animation. Influenced by the traditional celluloid style, 2D animation is extremely simple in terms of light and shadow performance, and the light and shadow performance of the objects irradiated by light is also relatively single, without changes in brightness and gradient, and only a single layer of color is placed on the base color of the layer as a positive overlay to show the volume of the characters and objects as a dark block, lacking brightness gradient (Figure 2).

Figure 2: 1994 ver The Lion King

1.2. Natural Light and Single Light Source

In addition to the simple presentation of light, the use of natural light and single light source is an important means of traditional 2D animation light processing [2]. The so-called natural light refers to the direct light from the sun or the scattered light from the sky, which has the characteristics of high brightness and large area. In traditional 2D animation, natural light is often applied as the main light source of the scene to provide a suitable space for the character performance and facilitate the narrative [3]. For example, in Figure 3, the room where the character Lazy Goat is located in Pleasant Goat and Big Big Wolf and the scene where Sakura is playing outdoors in Magic Card Girl Sakura, both use natural light, aiming to account for the environment and facilitate the performance of the animation character under the premise of reducing production cost. Single light source has the characteristics of small area, strong directionality, and concentrated brightness. Single light source is commonly used in traditional 2D animation to express the physical characteristics of the scene or to participate in the construction of the lens language. Such as Figure 3 of Detective Conan can be seen in the application of a single light source: the screen light from the right side, shining in the backside of Conan, the rest of the place are in the shade, the application of single light source is intended to express the psychological activities of Conan at this time: the suspicion of the people present, while creating a sense of insecurity atmosphere. It is worth mentioning that both natural light and single light sources are omitted in the application of traditional 2D animation, and only the shadows of the same tone are retained, which makes the traditional 2D animation look flatter [4].

Pleasant Goat and Big Big Wolf,

Magic Card Girl Sakura

Detective Conan

Figure 3: Domestic and foreign traditional two-dimensional animation screenshots

2. Light and the Composition of Three-Dimensional Space Influence Factors

2.1. Brightness Gradient

"All gradients have the power to create depth. And the luminance gradient is again the most powerful of them all. Not only in different spatial settings such as the interior of a room as well as in external landscapes but also in individual objects, it is wonderfully expressive." [5] In Art and Visual

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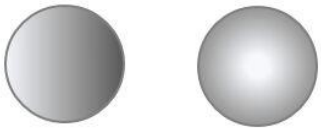
Perception, Anheim argues for the connection between light and three-dimensionality through Gehrke's and Lau's experiments in which objects are illuminated with sidelight to increase their three-dimensional effect. In addition, experiments on light exposure of stereoscopic models demonstrate that the gradient of light and darkness produced by light affects the stereoscopic perception of the viewed object.,

When we look at an object in isolation, it is impossible to see that the difference in the brightness above it is caused by the illumination of an external light source, but remains attributable to the real physical difference between white, black, and gray above it.

A surface can be obtained by accelerating the light gradient. However, when the eye looks directly at a raised surface, the convex object becomes flat, and its three-dimensionality gradually increases as it is accelerated from its center to its edges. Thus, by changing the steepness of the step, the shape of this convex surface can be controlled. A step that varies at a constant rate can produce an inclined surface effect, thus reflecting the physical fact that the inclination is constant throughout the convex surface. In Figure 4, when we do a comparison between a and b, we will feel that a is more three-dimensional than b - some. This is because the lightness and darkness in b are symmetrically distributed like a sphere. When viewing such a symmetrical pattern, it is difficult to obtain a sense of three-dimensionality, and the object does not convey a strong impression of being illuminated by an external light source. On the contrary, a the gradient creates an asymmetry that detaches from the object and becomes superimposed from the outside, making the pattern a sphere illuminated by an external light source at an angle, with a strong sense of three-dimensionality.



a *b*

Figure 4: Illuminated spheres

A clear or black-and-white distribution of light not only makes the shape of a single object neat and coherent but also has the same effect on the overall environment in which the object is located. The totality of things that appear in the frame of a painting or a stage can be seen as a large thing or as a combination of several larger things, where the smaller components are seen as parts of the larger thing.

Figure 5 shows the official drawing process, from which we can see that Klaus' idea of a two-dimensional simulation of three dimensions is in line with Anheim's discussion of light space in Art and Visual Perception, and the theory is properly applied to the production of the film. In the process diagram in Figureure 5, we can see the light and shadow with a luminance gradient used in the animation to achieve 3D: Figure 2 is a traditional 2D animation base, and in the process of drawing from Figure 2 to Figure 3, a right-hand light is used to increase the luminance gradient, making the character look more three-dimensional from Step 2 to Step 3.

Figure 5: The influence of light and shadow on the sense of 3D in animation film design

Black shading destroys or distorts the shape of things because it not only hides important parts of things but also destroys their continuous and consistent surfaces by cutting them off with a clear boundary line between light and dark areas. Adhesive shadows, only when their edges are partially blurred, can retain their transparent film character. Shining a strong spotlight on a sculpture creates the thick black contour lines argued by Hiren, relentlessly destroying the unity of the sculpture's surface and generating a meaningless black and white shape. Conversely, everyday light in daylight makes the sculpture look extremely beautiful because the diffuse nature of this light compensates for the negative

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effects of direct sunlight, creating a soft gradient of variation.

In Figure 6, the character Jasper is shown under different lighting, from left to right, the first one is the unlit Jasper, which is the same as the ordinary 2D animation and lacks the sense of three-dimensionality. The second one has sunlight from the side, and the character becomes three-dimensional, but the gradient of light is too small, and the contour line presented in the junction line of light and dark is thick, black, and stiff, the character looks very stereotypical, just like the early unrendered 3D mapping character, lacking realism and beauty. The third one is a bottom light from the bottom to the top, the light brightness gradient is large and soft, there is a small black shadow area, there is a gradient, enhance the three-dimensional sense of the character and the character in the space of the level, so that the character looks vivid and rich storytelling.

Figure 6: Role under different lighting

2.2. Multiple light sources

"To avoid confusion between the irradiated brightness and the hue of the object itself, the distribution of light throughout the environment must be understood by the viewer's eye. This is easy to do when using just one light source. But in photography and stage lighting, several light sources are often used in combination to avoid excessive shadows." In a gallery, studio or stage, to avoid crude lopsidedness in light exposure, it is necessary to combine the lighting of several light sources to form an organic whole. Several types of light can be added together to create a uniform illumination, or each illumination itself produces a kind of self-contained luminance gradient. If you want to make each light source cooperate with each other, the photographer must organize them into a ladder, so that one of them acts as the dominant "starter light source", while reducing the supporting power of other light sources. Therefore, it can be concluded that the combination of multiple lights is essential for the three-dimensional visual construction of flat images.

The reason why our eyes can see the rich and colorful world is because of the multi-light irradiation, the spatiality, three-dimensionality, structure and level of the scene need the irradiation and display of multiple light sources, and the shadows produced by the light can largely make up for the lack of composition [6]. Multiple light sources are an important means of transforming flat shapes into spatial shapes [7]. As shown in the animation screenshot in Figure 7, the natural light emitted from the moon at night in the distant part, the lights emitted from the residents' rooms, the lights in the town, and the reflections from the snow in the foreground part, and the reflections from the environment on the characters in the foreground part, multiple light sources are concentrated in one shot, rich in layers, which together create the 3D visual sense of the animation. The light sources in the animation screenshots are only the tip of the iceberg of the application of multiple light sources in the film. In order to maximize the three-dimensional characteristics of the film, the entire animation was designed with complex movements and huge scenes, and as many as eight layers of lighting were used in the post-practice process [8], allowing the artists to combine and use them at will, thus achieving a perfect "two rendering three". Visual effects.,

3. Summarization

Based on the principle of Gestalt psychology: the luminance gradient of light and the performance of multiple light sources make Klaus' "2D shift 3D" a reality. Without the attachment of light and shadow, it is difficult to produce a real sense of beauty even if the scene is delicate. Therefore, the 3D "magic" of flat 2D animation modeling lies in the balance achieved by the clever cooperation of light, through the principle of optical illusion brought about by light, so that the audience can see the

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existence of three-dimensional forms in the animation picture.

The success of Klaus broke the monopoly of 3D animation on realistic rendering of animation art and opened up a new possibility for 2D animation practitioners and enthusiasts. Klaus's director Pablo says: "I started my career when 2D animation was in its prime, but the boom of 3D animation has brought the development of 2D animation to a standstill, one of the consequences of which is that the 2D animation industry now has a talent One of the consequences is that there is a talent gap in the 2D animation industry. With the success of Klaus, it is hoped that the appeal of 2D animation to the market and a new generation of practitioners will be renewed." In the context of the high workload and high cost that 2D animation faces today, the only way to produce a more dynamic model of animation production is to continue to collide with other forms and find new inspiration from them. At the same time, we should pay more attention to the application of visual illusion in animation art design, to inject new sources for the development of 2D animation.

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