

Comparative study of motion in limited animation - Focusing on American Animation & Japanes Animation -

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리미티드 애니메이션에서 나타난 동작비교연구 -미국과 일본애니메이션 중심으로-

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Abstract The limited animation method which is a Japanese Animation frame production method was born in the U.S. but it is Japan where it was most actively used and developed. With this in mind, this researcher conducted a comparative study on the movements shown in animated films of the U.S. and Japan to identify success factors. For an analysis of the animated films of the two countries, first, the difference between orthodox animation and experimental animation was analyzed. Second, the concept of limited animation was reviewed, as well as its difference from full animation. Lastly, for an analysis of the difference between animations of the U.S. and Japan, 'Disney's 12 principles of animation' was applied.

Key Words : Orthodox Animation, Full Animation, Limited Animation, Disney's 12 Principle of Animation, UPA. Frames.

요 약 일본 애니메이션 프레임 연출방법인 리미티드(Limited) 애니메이션기법은 비록 미국에서 태동했지만, 일본에서 리미티드 애니메이션기법을 활용하고, 발전시켜, 그 근본을 흔들여놓았다. 그래서 본 연구자는 미국애니메이션과 일본 애니메이션 동작 및 연출기법을 비교, 분석하고, 두 나라의 리미티드 애니메이션기법이 어떠한 차이점이 있는가에 대해 살펴보았다. 두 나라의 애니메이션 분석에 앞서, 먼저 전통 애니메이션(Orthodox Animation)과 실험 애니메이션(Experimental Animation)의 개념의 차이를 살펴보았다. 그리고, 리미티드 애니메이션 개념을 살펴보고, 풀 애니메이션(Full Animation)과의 차이점 살펴보았다. 마지막으로, 본 연구의 핵심인 미국과 일본 리미티드 애니메이션의 차이 분석을 위해, 디즈니가 개발하여 확립시킨 이론 '디즈니 애니메이션 12법칙'에 적용하여 분석하였다.

주제어 : 리미티드 애니메이션, 전통 애니메이션, 디즈니 애니메이션 12 법칙, UPA, 프레임.

1. INTRODUCTION

Animation can be categorized into orthodox animation and experimental animation based on

style. The former is commercial while the latter is closer to fine arts. Specifically, orthodox animation emphasizes configuration, specific continuity, narrative form, evolution of context,

*This Paper was supported by the Se-Han University Research Fund in 2019.

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Received May 23, 2019

Accepted August 20, 2019

Revised June 25, 2019

Published August 28, 2019

unity of artist, absence of artist and the dynamics of dialogue. Meanwhile, experimental animation emphasizes abstraction, specific non-continuity, interpretive form, evolution of materiality, multiple styles, presence of the artist and dynamics of musicality[1].

Table 1. Difference between orthodox animation and experimental animation

Orthodox animation	Experimental animation
More commercial	Closer to fine arts
Configuration	Abstraction
Specific Continuity	Specific Non-Continuity
Narrative Form	Interpretive Form
Evolution of Context	Evolution of Materiality
Unity of Artist	Multiple Style
Absence of Artist	Presence of the Artist
Dynamics of Dialogue	Dynamics of Musicality

Animations can be categorized into full and limited animation depending on the frame production. Full animation makes movements more natural, and is the basis for surrealist orthodox animation. Disney is a leader in this method. The further the style is from that of Disney, the more they are unrealistic animation, abstract animation or experimental animation.

Then does the limited animation frame production method used in UPA(United Production of Animation) and Japanese animation not belong to orthodox animation? As mentioned earlier, both animation types are traditional animations but they are distinguished based on the degree of realistic expressive methods used for movements.

As such, this paper will analyze the difference and homogeneity of the animations of the two countries by looking at the U.S. limited animations, Gerald Mc Boing-Boing (1951) and The Simpsons (1989-2019), and the Japanese limited animations, Atom (1963) and One Punch Man2 (2019). Moreover, the concept of full animation will be described for better understanding, while there will be a limit to analysis of other data. The focus will be on character movements. Other

components such as character design, background design or story will not be addressed. Disney's 12 principles will be used to analyze the movements in limited animations of the two countries.

First, what are full animation and limited animation? Second, what the Disney's 12 principles of animation? Third, how are the movements in U.S. and Japanese limited animations analyzed?

Lastly, how are the two countries' styles similar and different?

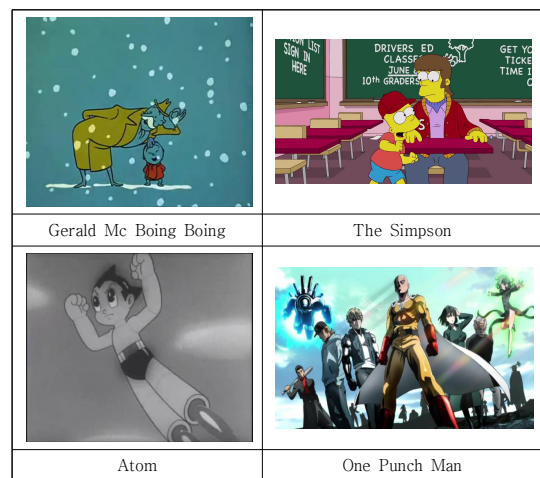


Fig. 2. Sample Images of Limited animations of U.S./Japan[11-14]

2. THEORETICAL BACKGROUND

2.1 Full Animation

Disney's animation is a leading case of full animation. In full animations, the moving object has more than 14,000 frames for 30 minutes. It is mostly used for animations shown in theaters[2].

The numerous image frames per second create a soft visual effect. Since producing full animations require artistic production techniques, it costs a lot of time and money. They are used mostly for long animations and TV advertisements. It is not appropriate for animations of low budget and low production time[3].

2.2 Limited Animation

UPA animation is a leading case of limited animation. Since UPA's Gerald Mc Boing-Boing (1951), the limited method became well known in Europe and Japan. Compared to full animations, more than two frames are repeatedly shot to make 12 frames per second. This is about half of full animations, giving it the advantage to shorten the production time[2]. UPA came as an uprising to the extremely realistic expression of animations and was led by Stephen Bosustow. It allowed for abstract expressions, repeated shooting of the same frame and intermittent movements of characters[3][9]. For these reasons, limited animations became most fitting for Japanese animations suffering financial difficulty after WWII as it saved costs[4][10].

3. DIFFERENCE IN THE PRODUCTION METHOD OF U.S. LIMITED ANIMATIONS AND JAPANESE LIMITED ANIMATIONS

In general, the limited method applies 2 frames at a time or 12 frames per second. So the torso wouldn't move but only the arms and face, or just the mouth. A good example of this is Hanna Barbera's The Flintstones (1960) [7][8].

Tezuka Osamu started to use the more economical and effective U.S. limited animation methods because TV animations need to fit into a broadcasting timeslot and have a short production period. Tezuka used the U.S. limited method for this reason, but improved the simplistic narrative structure of American method. Atom (1952) was born as a result. In fact, Tezuka applies the mie-pose used in traditional Japanese Kabuki to increase tension by stopping movements when emotions are high. That is, he leveraged the fact that even during close-up of characters time goes on, only the mouth would move during facial close-ups or

even the mouth would not move in certain scenes. Tezuka defined the economic rules for such animation production as in Table 2. It is evident that the U.S. limited method was more economically improved[3].

Table 2. Comparison of limited animation methods of the U.S. and Japan

	U.S. limited Animation	Japanese limited Animation
Frames per film	Approximately 5000–6000	Approximately 2000 or less
Frames per second	12–24 Frames	8 or less Frames
Character close-up	More than 1 moving image	1 image with camera tilting
Sweeping scenes of objects	1 moving image or cell is used for production	1 moving image or cell is used for production
Walk cycle scene	Slide the background to make it like they are walking	Slide the background to make it like they are walking
Limb movements used in the walk cycle or run cycle	Separate cells for arms and legs	Separate cells for arms and legs
Character mouth movements	Fit for minimal lines	Three types of opening, middle and closing
Re-use of the extreme pose	none	Re-use of past extreme pose
Cut exposure	Made short to address the weakness of limited method	Made short to address the limited method

4. DISNEY'S 12 PRINCIPLES OF ANIMATION

Disney's animation is based on realism and movements are realized through hyper-realist expressions. Hyper-realism in movements becomes the criterion against which movements are judged. In other words, animations are graded on how the animation strays from the principles, Disney's animations seek to apply a mechanism of a film. That is, the characters rendered from 2D images to 3D programs are expected to live and breathe. This can be interpreted as desiring to trick the viewers with

fake but perfect images[1].

Then what kind of methods are used to produce Disney animations that seek to achieve '1 Frame by 1 Frame'. Although there are components such as character design, texture, writing and story, we only focus on movements as the language for movement in limited animations. The 12 principles of Animation were conceived by Frank Thomas and Ollie Johnston and are as follows: Squash and Stretch, Anticipation, Staging, Straight Ahead Action and Pose to pose, Follow and Through and Overlapping Action, Slow In and Slow out, Arcs, Secondary Action, Timing, Exaggeration, Solid Drawing and Appeal. We look at the principles one by one[5].

4.1 Squash and Stretch

This concerns how the shape of characters change and how the law of conservation of mass must be observed and linked to exaggerated actions. In a ball bounce animation, when the ball's shape changes upon contact with the floor or other object, this rule can be maximized. It can also be applied to when a character squats then jumps up.

4.2 Anticipation

Anticipation is about giving the audience an expectation and following with the impact of movement and natural actions. Just as a pitcher brings back his arm to throw the ball, the exaggerated expressions of how characters bend their body in the opposite direction before running forward in Tom And Jerry (1940) and Scooby Doo (1960) are such examples. It must be used in regular movements, too, to make it feel real.

4.3 Staging

Staging is a general rule in both animations and films. Depending on the scene layout, camera usage and lighting, the image can differ

greatly. For example, if a ball bounces 10 times while it moves along the X axis and if a front shot of the X axis is shown, it would look as if the ball is bouncing in the same spot.

Walt Disney advised about staging that "Work in silhouette so the everything can be seen clearly. Don't have a hand come over a face so that you can't see what's happening." Staging is an important principle to make the audience understand the situation by clarifying the character's silhouette.

4.4 Straight Ahead Action and Pose to Pose

Animation production can be categorized into Straight Ahead Action and Pose to pose. First, in Straight-ahead action, Frame-by-Frame method is applied. this brings very natural movements, but it is challenging to fit into the time wanted. It is also difficult to revise or separate different tasks between numerous animators. Second, in Pose to Pose action, the Extreme Pose is expressed to fit a certain time and later between Pose and in-between Pose are expressed. This is also for work to be separated between a number of people, and it is also easier to divide time. So it is advised to set the Pose to Pose action first, then apply Straight Ahead Action.

4.5 Follow and Through and Overlapping Action

Follow and Through can be the opposing concept of anticipation. It refers to the response shown by the secondary parts to the main part's movement. For example, when a pitcher throws a ball, the arm also moves in the direction of the ball. When a golf club is swung, the arm moves along with the big muscles in the shoulder. When someone with long hair moves, then the hair moves. When a horse is running, his long tail moves along with the body's movement.

Overlapping action is when each part of the body is made to move at a different pace. For

example, when a fist is made, there is a lag between the different finger joints, or have lags in joints of the body when moving. Another example is when in a close-up shot of the face the head moves first when the character throws back his head to gaze upward. The eyeballs are set to move after a couple of frames.

4.6 Slow In and Slow Out

Movement at a constant speed cannot be seen unless it is artificially made. That is, movement at an accelerated pace is directly related to objects' movements. A good example is when one walks the pace of the arms moving also changes, too. When the arm drops, it changes 'slow - fast - slow'. When an object falls, there is acceleration of slow- fast- faster. And when a car starts or stops, the pace changes 'slow - fast- slow'.

4.7 Arcs

An anatomical drawing of Leonardo da Vinci shows the Arc of limb movements. That is, they do not move in a linear way. They move along an arc in a soft way. If these arcs are not achieved, it would look like they are shaking as if there were an earthquake. Therefore, movements must have an arc for the walk cycle to make them look natural.

4.8 Secondary Action

Secondary Action is expression of movements other than the primary action.

Secondary Action is closer to a narrative expression rather than a technical method. For example, when a character is eating food, bursts into tears or is walking, if secondary actions are added before or after the primary action the primary movements can be made more enriched Timing was called by Grim Natwick as "everything" to animation[6]. Animators need to ensure that the character has natural movements and appropriate timing. The number of frames need to be adjusted to apply spacing for the

movement in accordance with the character's weight or volume.

4.9 Timing

Timing was called by Grim Natwick as "everything" to animation[6]. Animators need to ensure that the character has natural movements and appropriate timing. The number of frames need to be adjusted to apply spacing for the movement in accordance with the character's weight or volume. This is about the three dimensional expression of characters. When seen from top down or from bottom up, perspective should be applied to give a realistic feel.

4.10 Exaggeration

Exaggeration is used to make characters or objects more like cartoons to add more fun or make expression more intense.

4.11 Solid Drawing

This is about the three dimensional expression of characters. When seen from top down or from bottom up, perspective should be applied to give a realistic feel.

4.12 Appeal

Appeal is about drawing the audience's attention by laying out props and backgrounds that fit the narrative structure. Inappropriate or disinteresting settings can make the animation boring for the audience.

5. ANALYSIS OF ANIMATION MOVEMENTS

'Fig.2' compares the limited animations of the U.S. and Japan based on Disney's 12 principles. Since of the 12 principles, Timing and Straight Ahead and Pose to Pose are necessary, they are

excluded from the comparison. Staging and Appeal were also excluded as they are expressed strategically through camera and lighting.

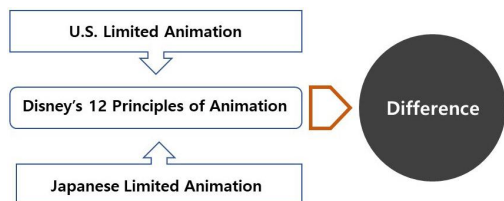


Fig. 2. Limited animations of U.S./ Japan based on the 12 principles of Animation

5.1 U.S. Limited animations

First, in terms of the 'Squash and Stretch' principle, it has been applied to the scene where the parents and doctor is thrown back at the voice of Gerald in Gerald Mc Boing-Boing. Exaggeration has also been applied. Gerald Mc Boing-Boing is a cartoon-style animation, so there is no accurate movement principle applied to the Squash and Stretch principle.

In the Simpsons, there is Squash and Stretch applied to the mouth movements. This can not be seen as based on movement principles, but rather linked to the exaggeration principle.

Second, in terms of the arc principle, Gerald Mc Boing-Boing uses a limited animation method focusing on extremes. As such, the arcs of the route and the arcs formed by the swinging arms that occur when walking were mostly ignored due to the height of the extreme and passing point when walking. However, when Gerald grabs the microphone to say something or stand up, there was an accurate arc as in a full animation. A similar arc principle was applied to the route the paper dropped by Gerald's mother takes. The arcs character movements in The Simpsons were similar to those of Mc Boing-Boing. Since there were such few frames connection of movements appeared rigid, but the arc principle was still observed.

Third, in terms of anticipation, Gerald Mc Boing-Boing did not have anticipation apply to

all movements but only intermittently. It was applied to Gerald walking listlessly when he throws back his body and head, or when the angry father makes a hand gesture in the toilet. In the Simpsons, anticipation is mostly ignored and is only found in arm movements.

Fourth, in terms of Follow and Through overlapping, the bundle that Gerald has on his shoulders when he leaves home responds accurately to the child's movement, showing the application of this principle. Overlapping was not applied consistently to the time lag between boy joint movements, but was applied to when the child gives a signature or when the arm rotates when the parents walk in the end. The two principles were ignored in The Simpsons.

Fifth, the Slow and Slow out principle or acceleration were ignored in both animations.

Sixth, the Secondary Action principle is applied to the response of parents and other characters, specifically their hand gestures as Gerald is depicted as a child that cannot speak but only makes sounds. Overall, Gerald Mc Boing-Boing features good use of the Secondary Action principle. In the Simpsons it is applied generously, including when the protagonist Bart flicks his finger before driving or when he complains after his friend tries to strangle him.

Lastly, Exaggeration is applied to the geometrical arm movements of the character or when the character is surprised as was the case for the squash and stretch principle in Gerald Mc Boing-Boing. Even in the depiction of characters, a nose that is out of proportion or thinner and longer limbs are examples of exaggeration. In The Simpsons, the overall color of yellow, big eyes and exaggerated mouth are such examples. In expression of static movements, no exaggeration was used. is about drawing the audience's attention by laying out props and backgrounds that fit the narrative structure. Inappropriate or disinteresting settings can make the animation boring for the audience.

5.2 U.S. Japanese limited animation

First, the ‘Squash and Stretch’ principle was applied only when characters had a surprised facial expression in Atom and One Punch Man2.

Second, the principle of Arcs was applied only when setting the flying route of Atom. Even in a walk cycle, the arc for the height of the extreme and passing point was not applied. In One Punch Man2, arcs were not much applied when the character was walking, rising up, or sitting while throwing his head back. Overall his movements were unnatural.

Third, the Anticipation principle was ignored in both Atom and One Punch Man2.

Fourth, the principle of Follow and Through and Overlapping was applied when to the hair and long beard of characters in Atom and One Punch Man2 when they were moving, but the movements were inaccurate. Overlapping did not occur at all.

Fifth, Slow and Slow out principle was not applied to Atom or One Punch Man2 where acceleration was ignored.

Sixth, Secondary Action was hardly applied to the characters in Atom. For example, when Doctor sobs after losing his son, there is only a slight shaking of the shoulders. In One Punch Man2, there was some secondary action with the characters having a funny facial expression or making certain movements before making primary actions.

Seventh, although Atom and One Punch Man2 are science fiction animations with a lot of fighting scenes, there were no particularly exaggerated movements. Rather, they used timing and editing of camera frames to give a sense of speed to make up for it. Of course characters were depicted as more beautiful or uglier.

Lastly, the principle of Solid Drawing was applied well to Atom and One Punch Man2, as was in U.S. limited animations. the three dimensional mass was respected and perspective was applied to show proportions. in terms of the

‘Squash and Stretch’ principle, it has been applied to the scene where the parents and doctor is thrown back at the voice of Gerald in Gerald Mc Boing-Boing. Exaggeration has also been applied. Gerald Mc Boing-Boing is a cartoon-style animation, so there is no accurate movement principle applied to the Squash and Stretch principle[15].

Table 3. Whether the 12 principles of animation are applied

	12 principles of animation	U.S. limited animation	Japanese limited animation
1	Squash and Stretch	○	Very intermittent x
2	Anticipation	intermittent ○	x
3	Staging	○	○
4	Straight Ahead Action/ Pose to pose	○	○
5	Follow and Through/ Overlapping Action	○/ x	○/ x
6	Slow In and Slow out	x	x
7	Arcs	intermittent ○	○
8	Secondary Action	○	intermittent ○
9	Timing	○	○
10	Exaggeration	○	x
11	Solid Drawing	○	○
12	Appeal	○	○

6. CONCLUSION

While the U.S. limited animations had a clear characteristic of reducing number of frames and depending on the camera work and narration for halted movements, there were still remnants of the 12 principles. While the number of frames for the mouth shape or facial expression were significantly fewer, there were attempts to match the shape of the mouth to what was being said to reduce awkwardness. In addition, secondary actions were used to add fun to movements and prompt interest. Although intermittent, the principle of anticipation was applied. The Follow

and Through principle was also well applied by having other body parts move in association with the main torso movements, but due to the fewer number of frames, they did not look natural. However, with quick editing and technology, they were enough to trick the viewer. In particular, parts about acceleration did not stand out much. Of course, the principle of overlapping where there is a lag between joint movements was applied only in a limited manner.

Since Japanese animations have fewer frames than U.S. counterparts, Squash and Stretch or Anticipation principles were hardly applied, as were Follow and Through or Overlapping. When the Arc principle was ignored, there were more linear movements where the action would go from one extreme pose to another, with the passing point being ignored. The Secondary action principle was applied somewhat, perhaps because of the many constraints on number of frames. Exaggeration was not done except for character design and Squash and Stretch associated with exaggeration was also lacking.

The comparison of U.S. and Japanese animations based on the 12 principles of animation by Disney shows the difference in movements. Of course, neither one of them can be said as superior to the other. But understanding these differences would be helpful to suppliers or students of animations. This researcher hopes to see more research and products related to animation techniques based on this paper. tables must be numbered consecutively. Table headings should be placed above the table. Tables should be as close as possible to where they are mentioned in the main text. Tables can span the two columns if necessary (for those who use two-column format).

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