Analysis on Laika's Puppets in Kubo and the Two Strings: A Stop-Motion Animated Feature

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Abstract. Stop-motion is one of the highly regarded animation/film techniques in the industry. Although infamous for its long production time, stop-motion can take advantage of literally every other artform and technology. But, one medium that stop-motion never strays far from is puppetry. This is because puppets can easily be made to resemble living beings. Also, they are reusable. In this digital age, efficiency and effectiveness became the top priorities in any form of production. In this context, puppet animation (puppetry in stop-motion) is considered too pricey and not ideal for the rapid competition happening throughout the industry. This is why the genre started to fade in the '90s. Fortunately, a western animation studio bearing the name Laika brought puppet animation back to life, making the genre popular again. Their works reached the hearts of their audience through smooth animation, breathtaking visuals, and cool-looking puppets. This may seem like a mere pipe dream for their predecessors, but Laika has done it with the help of cutting-edge technology — making the production process way cleaner than ever. As time keeps on flowing, innovations and new ideas are needed to sustain creativity and value in the industry. Therefore, this journal is a study to prove how relevant Laika's innovative puppets are in the stop-motion world. All data used in this journal is acquired through literary studies across the online web.

1. Introduction

Stop-motion is a technique that has been used since the late 1800s to create an illusion of movement to inanimate objects. This technique can be done by everyone and with any objects, ranging from amateur cutouts to lego fan shorts, or big productions such as the 1933's *King-Kong*. Though most of the time, puppets are inseparable from stop-motion works. Silicon puppets with metal armatures inside are the type of puppets commonly used for those. They are later wrapped with costumes or animal fur to form an iconic character [2]. As time went by, puppets in stop-motion were pushed even further with the help of 3D printing and robotic technology. 3D printing allows smaller and more complex parts to be made, while robotic technologies allow artists to create and move enormous rigs to convey the size of the creature on screen, resulting in even better puppets for smoother animations. One particular studio has been experimenting with 3D printing and the use of animatronics to aid the puppets in their stop-motion works. This particular studio is Laika, an American animation studio, specializing in stop-motion feature films. It is owned by Nike co-founder Phil Knight, and his son, Travis Knight, who acts as Laika's president and CEO, also as director for some of Laika's feature films [11]. One of their films, Kubo and

the Two Strings, will be the main subject of discussion in this journal.

Kubo and the Two Strings is an epic action-adventure stop-motion animation film set in the whimsical world of Japan. Kubo, a clever and kindhearted boy, makes a modest existence by sharing stories with the citizens of the seaside town. But it all changed, when Kubo unintentionally summons a vengeful spirit from the past, his quiet life as he knows it is over. Kubo joins up with Monkey and Beetle to uncover a hidden legacy while on the run. Kubo must defeat the Moon King and other gods and demons with an enchanted instrument to rescue his family and solve the mystery of his fallen father, the greatest samurai warrior the world has ever seen.

The unique and complex puppet design in this movie is enough to surpass their predecessors. Thus, the aim of this journal is carried out to prove how Laika's innovative puppets can help make future stop-motion productions more effective thus staying relevant in the animation industry.

2. Theory Overview

A. Stop-motion

Stop-motion is an animation/film technique that utilizes photographic methods to create a sequence of images, leading to a complete motion picture. This technique requires objects to be physically manipulated in front of a camera, then photographed as many times as changes are done to them. Putting the multiple pictures together and playing them back will result in an illusion of motion. Considering the essence of stop-motion is the photographic method, any kind of object, artform, or known technology can be used to produce a stop-motion product. Though in stop-motion history, puppets (with modifiable joints) and clay figures are the most commonly used.

The name stop-motion came around a few decades back, when *The Humpty Dumpty Circus* was released in 1898. It was considered the first-ever documented stop-motion film created by J. Stuart Blackton and Albert E. Smith. They were using their daughters' dolls as the main attraction to tell a story about how everyday life in a circus would be like. Since then, stop-motion has become a new playground for both filmmakers and animators at the time. That's when legendary figures in the industry, Willis O'Brien and Ray Harryhausen started to become known. Through their works, stop-motion found its way to blend in with live-action shots. One of the most famous examples of this was done in the 1933's *King-Kong* movie [2].

Stop-motion reached its peak in the '70s and '80s, being used in lots of music videos, adverts, and huge movies (*1984's Terminator*, *1987's RoboCop, etc.)*. Unfortunately, technological advancement in the '90s became the downfall for stop-motion works. Digital VFX and CGI (Computer-Generated Imagery) started to steal the spotlight, mainly because of their looks and effectiveness. Today, the charm of stop-motion is being relived by animation studios such as Laika [4].

B. Puppetry

Puppetry is considered one of the oldest forms of entertainment to date. In resemblance to a theatrical performance, puppetry relies on a play of puppets to tell stories, rather than using human actors. The puppets' movements, gestures, and expressions are manipulated behind the curtains by a puppeteer. How they are manipulated entirely depends on the puppets' design. String puppets, rod puppets, and hand puppets were the most popular at their times.

This form of artistry dates back to 2000 BCE[1], where ancient Egyptians created the first prototypes of string puppets from wood. Rod puppets are found later in the first millennium, playing across shadow theatres in China. Following the rapidly increasing technological

1 BCE stands for "Before Common Era".

advancements, puppetry kept on improving in a lot of ways — better staging, lighting play, materials, quirkier puppet design, and more methods to hide puppet manipulators from the audience. This eventually led to the founding of puppet animation in the late 20th century.

Puppet animation can be seen as a hybrid between stop-motion and puppetry. In this context, the puppets' manipulators are made no longer visible to the human eyes by reallocating them as metal skeletons inside each puppet. These hidden rigs are known as armature. They enable the puppets' body to be adjusted and moved freely to their heart's content. This way, puppet animation makes it seem like the puppets are alive and performing on their own. Nowadays, there are even mechanized versions of these puppets [5].

C. Rigging

As of the latest Merriam-Webster dictionary, rigging is a similar network used for support and manipulation. These so-called networks are often found hiding behind every finished artificial product revolving around human life. Architecture can be considered one of the common examples of rigging. Before skyscrapers grazed the clouds, architects designed a "skeleton" to keep the building standing. They usually take form in systematic metal crossings that are welded together to match their corresponding blueprint. Walls and floors are then built on top of them to form the final product, concealing the rigs from plain sight. A more flexible rig can be found on turnover bridges, where some kind of hinge is added to manipulate the bridge's movement.

The very same principle is applied as a technique in the animation industry. In this context, rigging is a process of creating bone structures for 2D assets or 3D models. These bones are later used to manipulate those rigged objects like a puppet, ready to be adjusted and distorted freely for animation. Rigging is commonly used in animated characters and creatures that are supposed to breathe, act, and express. In other words, they represent bones and muscles that living organisms depended on in life. How the rigging process is done, primarily depends on what kind of animation is pursued.

Back in the day, digital rigging process was always superior to handmade rigs. This is because rigging can be done effectively and less costly through one digital software, that only requires software knowledge, patience, and mouse clicks. In opposition, rigging for traditional (hand-crafted) animation required more budget for the materials and surely more time-consuming. Though as technology advances, 3D printing has created an effective option that enables animators to print digital models into several separate parts. The printed parts can then be put together into an adjustable puppet, as long as the animator included fitting slots in each part when they were modeling the parts digitally [1].

3. Methodology

As the name suggests, a literary study or literature review is a research method that focuses on searching and evaluating available literature concerning a specific topic. The literature mentioned revolves around articles, journals, papers, news, etc. There are supposedly several approaches available to utilize this method — this journal chose the online approach to find related archives on the internet. After finding the needed literature, further steps were taken to analyze and study the residing information thoroughly. Several articles that hold the same information went through comparison, where the one with the strongest arguments was picked. Finally, results were squeezed into conclusions and cited as sources that helped with the current analysis on the subject matter.

4. Discussion

A. Creating Kubo, Monkey, Beetle, and Moon Beast

Kubo and the Two Strings displays unique character design and sophisticated stop-motion puppet technology. Four of the many characters in this movie are Kubo, Monkey, Beetle, and Moon Beast, which we will use for discussion in this journal. Each character has its own uniqueness and challenge to make into a puppet. Kubo, the main character of this movie is the most basic puppet out of these four characters. Basically, every puppet is made with a steel armature inside so the animators can move and pose the puppets easily while still able to hold their pose and position. Then the armature will be covered with a silicone body which will be the base of their appearance. After that, the costume departments will make a small costume for each puppet. Their costumes are made with various materials, depending on the character concept. Then a 3D printed head mechanism will be attached to the body armature, and if the character has hairs, real human hairs combed with silicone to make it durable and poseable will be attached to their head.

Figure 1. Puppet of Kubo.

Figure 2. Character Design of, Beetle, Monkey, and Moon Beast.

But, due to their design which features fine hairs, sharp angles, and small sharp little parts on their face, these characters push Laika studio to figure out ways to create a new method to be able to 3D print faces with those features. Their previous method before making Kubo was to print face models with powder-based material and dipped it in glue to make it sturdier, but this method produces a fragile faceplate that is easily damaged and ruptured, so it isn't a viable method to create sharp and small pieces for characters such as Monkey, Beetle and Moon Beast [6].

To solve this problem the technical team at Laika studio decided to team up with Stratasys, a 3D printer company they have been working with for their previous films. Initially, Stratasys only had a machine to print plastic-based materials with 3 colors blend and can only be used to make a gradient with 46 colors palette, and no viable way to assign colors specifically. So, the technical team at Laika decided to make their own software to be able to assign colors to the final printing result and expand

its palette into 256 colors. This collaboration between Laika and Stratasys resulted in a new method to create a plastic-based 3D printing method that will enable them not just to print complex structures with colors but to also print colors according to an artistically rendered texture map [6].

Figure 3. The technical team at LAIKA Studio managed to expand the originals color palette from 46 colors into 256 colors, and able to assign specific colors to specific locations.

This technique also allows them to print small and complex detailed forms for the internal mechanism for the puppets, which results in a sophisticated rigging system for the armature, especially in the head area as you can see in the picture below.

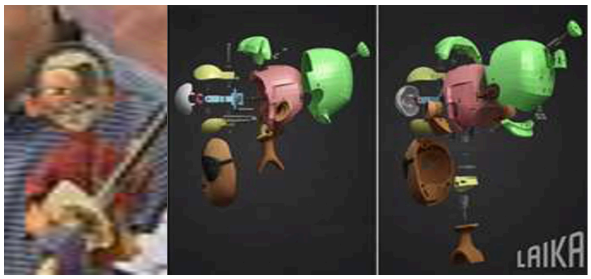

Figure 4. Plastic-based 3D printing technique allows LAIKA to create complex mechanisms for the puppets.

This complex head structure is then magnetized in the corners of the face areas, allowing animators to easily change the faceplate to change facial expression for replacement animation. These faceplates are also coded so that face librarians can easily find faceplates according to the animator's needs to make a shot and put it in a kit for the animators to use [7].

Figure 5. Over 23.000 3D printed faceplates were used in the production of Kubo and the Two Strings, each faceplate have their own specific codes.

They also create a system to track faceplates for each frame, by using a dope sheet containing the frame number and the code that should be used for that frame. The faceplates have been determined for the scene on the computer beforehand. That way, the animator knew when the facial expression had to be changed according to the puppet's movement as well [8].

Figure 6. Dope sheets to keep track of every frame.

Another amazing thing this technique was able to achieve is a fully 3D printed puppet. This means this puppet didn't go through silicone molding or traditional sculpting process to create its body parts. Because of their new technique to 3D print highly complex shaped plastic-based material, the Moon Beast puppet is created by first modeling and texturing it in 3D software, then it got printed and cleaned. In the end, they managed to fully 3D print over 150 body parts, then all of those parts are assembled in a gooseneck armature allowing smooth animations and subtle control for animators to play around. This puppet is evidence of Laika's new puppet-making technique with 3D printing method capabilities [6].

Figure 7. Fully 3D printed Moon Beast Puppet.

B. The Evil Giants

This film is about an intimate family story in a fantastical world, but one of the biggest parts in this film becomes amazing is the presence of monsters. These monsters are also very large, much larger than the average human scale. The first monster was *The Giant Skeleton in The Hall of Bones*, at 16 feet tall and weighing 182 kilograms, this scale for stop-motion animation features had never been done before. The Giant Skeleton is one enormous masterpiece driven by computer programs and human muscles, this monster is like a marionette that is hooked up by wires to the roof and tied to a sandbag on the floor. The parts that are moved by human muscles are the hands and the head, while the torso is moved by a computer program [10].

Figure 8. The Giant Skeleton puppet in the set of Kubo and the Two Strings.

The other creature is the giant eye in *The Garden of Eyes*, this monster has a mesmerizing Moray effect to give that hypnotic look to the creature. This creature is 8 feet tall and they use metal mesh to cover the entire inside to reflect the light, on the inside they use rotating lights that counter-rotate amongst the plastic globes to give that speculoos effect on the outside so that it feels like the lighting is underwater. Although, this humongous puppet seems impossible to adjust with only human strength. This is why they programmed it to read the XYZ coordinates of a bowling ball to give a better performance to the movement [9].

Figure 9. The giant eye puppet and its eye mechanism.

5. Summary

Technological advancements allow an idealistic project such as Kubo and the Two Strings to succeed. Back then, stop motion artists would've never imagined the possibilities of making such detailed and seamless motions from a mere puppet. Now such things are made possible, with the most advanced 3D printing technology and software. Laika has blurred the line between stop-motion and the art of puppets, making them less separable. This opens new doors of opportunity for puppet makers to step up in the animation industry. Not just that, Laika's puppet design may be fueling fresh ideas for the toy industry. — for the better. So, are Laika's innovative puppets proving to help stop-motion productions more effectively? Definitely, considering their puppets are so expressive that they could even compete with modern 3D CG animation films.

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