
International Journal of Creative Multimedia

Investigating How Frame Rates in Different Styles of Animation Affect the Psychology of the Audience

Sharafina Teh Sharifuddin,
sharafina.teh@mmu.edu.my
Multimedia University, Malaysia
ORCID iD: 0009-0006-7362-5898
(Corresponding Author)

Vimala Perumal
vimala.perumal@mmu.edu.my
Multimedia University, Malaysia
ORCID iD: 0000-0002-9263-8049

Hushinaidi Abdul Hamid
hushinaidi@mmu.edu.my
Multimedia University, Malaysia
ORCID iD: 0009-0003-1780-5868

Abstract

As an art form that has existed since nearly a century ago, animation has birthed many different techniques of presenting visual motion to the audience, either in a more familiar, realistic representation or a stylistic visual choice that goes beyond imagination. Various elements such as characters, objects, environments and abstract constructs are combined into one cohesive shot and subsequently, several of these shots are compiled to create one scene in an animation production. Among these aspects of animation that have to be taken into consideration heavily by animators, is frame rates, or more commonly known and abbreviated as FPS (frames per seconds). The definition of frame rate is basically the amount of frames or images that are playing within one second exactly in a time-based work. There are several variations of frame rates that are used by different styles of animation, whether it is traditional hand-drawn 2D animation, fully computer-generated 3D animation, stop motion and even hybrids of these different methods. One such example of an animated work in recent years that has pioneered the usage of different frame rates in their production is the animated feature film by Sony

Animation, Spiderman: Into the Spider-Verse, and its sequel which was newly released in theatres, Across the Spider-Verse, among other examples as well, but for this film in particular, the usage of different frame rates was intentional. In this article, how different frame rates are utilized in different forms of animation are studied by analyzing different existing examples that have been published for the general audience in movie theatres, online streaming and television, as well as exploring the function of different frame rates and the effect that they have towards the audience's psychology as well as in the context of storytelling when it comes to presenting their characters' personality and background.

Keywords Frame rate; Animation; Audience's psychology

Received: 31 July 2023, **Accepted:** 8 September 2023, **Published:** 30 September 2023

Introduction

The application of frame rates in various media productions, be it live action or animation has been one of the most important aspects to keep in mind in this day and age, especially seeing as these medias are often played in different devices with different settings and engines that would either take away or contribute to the smoothness of the playback of the video. Typically, in the earlier days of movie-making and entertainment, most films would settle with 16 to 24 frames per second (FPS) but often the rate can change as cameras were manually cranked by hand and it depends on the filmmakers on what kind of mood to implement towards the current scene that they are filming. Sometimes, to simulate certain types of motions, such as with a smooth movement or something with more jerks and irregularities, the filmmakers would usually change the frame rate to fit what they wanted, or if they had wanted to increase the speed of film, whether making the scene or shot faster or slower (Walter, 1975). They would do this by switching projectors as well during the screening of the film to help them with emphasizing the mood and atmosphere of the story. As time slowly progressed until late 1920s, the standard frame slowly increased to a range between 20 to 26 FPS. When sound films made their debut in the media and entertainment industry and became more popular, a compromise was reached to standardize the frame rate to 24 FPS due to having to match it with sound since it needed to have a fixed rate.

In the age of modernization, video transmission through television was kept at a rate of 60 FPS but lowered at a very minimal rate as black and white adjusted towards colour television that caused an effect called “dot crawl”, which is commonly known as a defect of colour that causes a checkerboard pattern to appear on screen. The standard of 60 FPS still remains until today in North America, Japan and South Korea. In film however, the standard of frame rates are usually kept to 24 FPS, but there are issues especially regarding judder, or some sort of vibration and irregularities in playing back the films. These days, videos can be played at a high rate of 120, 240 and frames can be evenly sampled for standard frame rates such as 24, 48 and 60 FPS for films and 25, 30, 50 and 60 FPS for videos (Armstrong, et al., 2008).

As for animation, the animators have a specific system to determine what kind of frame rate they would like to apply into the animation that they are creating. These terms are called ones, twos and threes. Sometimes, there would be different variations of other numbers like sixes, as established by current works like in the newest example that will be mentioned here, which is Spiderman: Across the Spider-Verse and the process of getting into creating a new

system to animate with differing, uncommon frame rates will be explained further later on in this article. Ones, twos and threes basically refers to how long a single image retains within the duration of a second that has 24 FPS, which is the standard frame rate for film. Ones meaning the single image will last for a frame in the second, twos meaning the image will remain the same for two frames within a second and threes are for three frames in a second. To explain in a more basic term, ones would have 24 images in a second, twos would have twelve (as 24 frames divided by 2 equals to 12) and threes would have only eight images. This is the general method in determining the frame rates that animators would like to work with when they start on the animating process, depending on the effect that they are intending to showcase to the audience.

Typically, in a standard hand 3D animated film, filmmakers would choose to have the shots animated mostly in 24 FPS, as it creates movements that are smoother, and thus more pleasing to the eyes of the viewers. However, they would usually compromise to have different frame rates for certain shots that might have a different speed and rhythm to suit the atmosphere more. For a fully computer generated animation done in 3D however, the software engine would usually have some presets of frame rates that the animator can choose to apply into their animation. For example, the most used 3D animation software, Autodesk Maya, would have the frame rate setting in the timeline and depending on what it is set to, whether 12 FPS, 24 FPS, 30 FPS or even 60 FPS, the timeline would transform and show the set number of frames within one second duration in the timeline. The animator can choose to key in how long they want the shot to be and the number of frames will be multiplied with the frame rate to show how many frames will be included in the animation.

In the olden days of animation where animators animated frame by frame with traditional paper and pencil method, they would have to label the frame number with numbers on the corners of their papers to label and mark them, obviously to keep track of the frame images. If the animation was set to be 12 FPS, then the labels would be 1, 3, 5 and so on to correlate with the frame distance between each other in the standard film's 24 FPS (Williams, 2009). With the progression of technology in the modern era, animators, especially those who are working with complete computer generated animations, implementing different frames into different animation projects can be done automatically using the software engine and does not need any manual interpolation or manipulation from the animators themselves. However, with current animated films like Spider-Verse that require many different frames playing within the

same scene or even the same shots, the animators do need to be aware of the numerical system to imply the frame rate that they want to apply towards the shot.

Aside from production reasons, there are several other purposes for different uses of frame rates for one single style of animation that is applied by animators, mostly for the audience's viewing and to affect how they see the story and the characters. Each animation medium has their own standard frame rate that has been set by industry practices, but on certain occasions, the animators deviate away from the common frame rate to achieve a different effect towards the audience.

Literature Review

For the literature review, a few animated films and techniques were broken down and analyzed, together with some publications of animation and frame rate to help explain the functions of certain frame rates and the implications it could have towards the audience's perception and psychology.

General Frame Rate Specifications

Generally, 3D animation or fully computer generated films are animated with 24 frames per second as this is the standard frame rate that is used in films. It's easier to animate with 24 FPS for 3D animation as the in-betweens of the keyframes are automatically calculated within the software that the animator used. When it comes to traditional animation, each single frame that is visible to the eyes of the audience needs to be hand drawn individually; therefore they are commonly animated with a lower frame rate, mainly 12 FPS. There are certain exceptions, especially when it is digitally hand drawn in software that has similar capabilities with 3D software, to calculate and interpolate and apply the missing frames between the main keyframes. One such example would be Adobe Flash or what is more now known as Animate CC, which has a feature called Tweens, short for "in between", that could apply interpolation between set keyframes to create a smooth animation in the software. The film industry standard for fully computer generated animation software would be Autodesk Maya, where creating every single frame would have no challenge to the animators. However, some filmmakers, especially those who are experimenting with different styles of animation, stray away from the standardized 24 FPS frame rate for 3D animation to achieve a certain effect that helps to manipulate the way the

audience perceives the shot or even the overall scene. There are a lot of recent animations that demonstrate this trend of animation lately, the most well-known and globally successful being the Spider-Verse films, the latest having been released in 2023.

Hand Drawn Animation

Older cartoons, from the beginning of its conception in the 1920s, prioritize smoother movements as they are influenced by the rubber hose type of animation, which showcases characters moving with a rubbery, flexible movement, with curvy, bending limbs, hence the name “rubber hose”. The smooth and rubbery movement evokes a feeling of flexibility and exaggerated movements, which helps with a lot of comedic scenes where ridiculous, over-the-top moments happen, to encapsulate the era of vaudeville, which is a type of entertainment rooted in comedy, song and dance (Crafton, 2012). To ensure that the motion that the character produces in the animation, the animation tends to be animated at a frame rate of 24 FPS or higher. Older animations are not equipped with the technology and software that they have today in the industry, and relies on traditional methods, such as using a light table and papers to draw the frames of the animation one at a time, so the animations usually take a longer time to finish, and it also depends heavily on the number of animators working on the production.

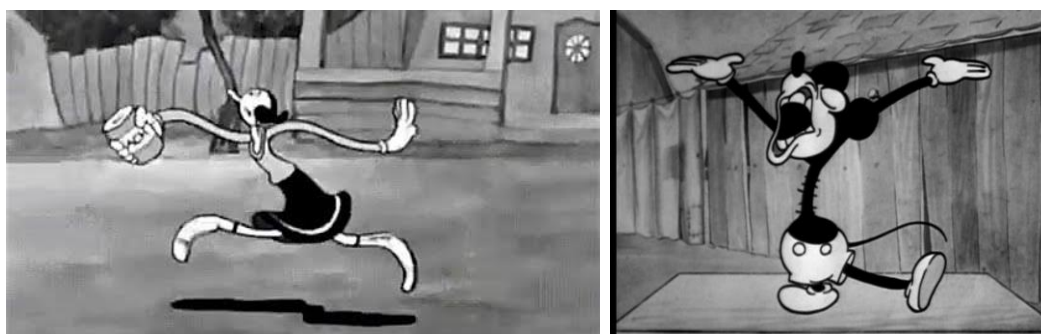


Figure 1-2 Examples of Rubber Hose Animation in Black and White Back in the Early Days of Animation in the Early 1900s

To save on costs and manpower, production usually reduces the animation to 12 FPS, and this is usually visible in many animated productions that are being broadcasted on television and it became an industry standard practiced by companies who produce 2D animated works. By reducing the number of frames needed to draw for one second of animation, the production saves more time and is able to increase the amount of content that they can put out for the audience (Japanpowered, 2023). This type of arrangement for animation production is visible in many television networks’ 2D animated productions, like Cartoon Network, Nickelodeon and

many Japanese animation productions, and sacrifices the quality of character's motion for the sake of quantity and time efficiency.

For an animated film that has theatrical release, they usually will receive an allocation of a bigger budget, which usually allows for a longer time and more manpower for production. There aren't many animated films these days that utilizes 2D hand drawn animation due to 3D being a more common choice with the progression of 3D software and technology, as it allows for more flexibility and saves more time because all the frames are already interpolated automatically when the main keyframes are set (Lamotte, 2022). There are several animation studios that still practices traditional animation, at least in the age where many studios are slowly adapting to 3D, one being Studio Ghibli from Japan. A majority of the films produced by the studio were crafted with hand-drawn animation, a traditional method that usually is not adopted by many studios any longer, and in recent years, include implementation of 3D technology to assist in production. In films, a majority of the films produced by Studio Ghibli is animated with 12 FPS, as some frames are repeated, but there are several sequences where the animators decided to implement higher frame rates. On some instances this was done during quiet scenes where the characters' motions and expressions are in full focus, and in others, a scene that contains a lot of actions or something with more surrealistic elements to them.



Figure 3-4 Stills from the Studio Ghibli Film; Howl's Moving Castle in Scenes Where the Higher Frame Rate (24 FPS) is Applied

For intimate scenes where the characters' faces are usually in focus, animating the characters in a higher frame rate will allow the audience to pick up on the intricacies of the acting shown by the characters, whether it's a twitch in the face, a shift in the eyes or any small gestures in their body, hands and head as they express what they feel (Khalil, et al., 2018). For action scenes, because the motions presented on screen can be quite fast and the audience will have a hard time processing the sequence of the motions and what is happening on screen, sometimes

animating the movements in 12 FPS might leave out some important keyframes that could help smoothen the motion. So usually every single frame of any sequence involving high speed movements that should not be repeated back to back is required to be different from each other to ensure the transitions between the main key poses or keyframes are seamless (Pazhoohi, et al., 2021). Having more frames to capture these movements and visuals enables the audience to digest the visuals better as the motions are smoother with the higher frame rate, and consequently, adding more hyperrealism, thus creating relatability towards the audience's own real life experience.

In terms of surrealism, the usage of high frame rates in traditional hand drawn animation has never been more notable than in an older animated film called *The Thief and the Cobbler*, released in 1995, after an extensive thirty years of production. The film had undergone multiple challenges along the way, from gaining the rights over the original story of the film, disagreements on the script, and losing funding from investors throughout the 70s and 80s, to high production costs due to Richard William, the director's complexity in the fluidity of his animation. Consequently, the final product of the film suffered intensely due to conflicting ideas in the plot, but overall in terms of the quality of the animation, it did not suffer due to the diligence of Richard William, who was considered one of the great masters of animation back in his time and even until today (Allison, 2021). Many scenes of the film displayed surreal imagery and animation, with characters moving through environments and having the illusions of a 3D space despite being animated in 2D. This was all achieved through the persistence and ambition of Richard Williams, an animator with strong traditional values as he painstakingly painted each single frame by hand and animating at 24 FPS, which meant that he and his team of animators had to draw 24 frames for just one second of duration. The high frame rate combined with the surreal visuals emanates a hypnotizing, abstract imagery that keeps the attention of the audience while keeping the animation interesting and appealing.



Figure 5 A Still from the Film, the Thief and the Cobbler, Showcasing One of the Many Hyper Surrealism Visuals

Stop Motion Animation

Stop motion animation in modern age has become more fluid and animated with a higher frame rate, and this is visible in animation studios that prominently uses stop motion as their main medium, such as the well-known Studio LAIKA that have produced several full length animated feature films such as Paranorman, Coraline, and Kubo and the Two Strings. With the emergence of Studio LAIKA, came new techniques, such as implementing the use of hand drawn and 3D animation in post-production and advancement of technology that assists in creating a smoother animation with a higher frame rate (Maselli, 2018). Generally, ever since its introduction to the animation industry, stop motion has always been animated with a lower frame rate and this is always due to several factors. One major reason for this is the production costs it would take to animate in higher frame rate, as it requires the usage of cameras and adjusting the positions of the handmade puppets and objects one frame at a time physically. Inherently, because of this, the standard frame rate for a common stop motion production is set at 6 FPS and 8FPS, or fours and threes respectively, which requires less frames to be animated for the duration of one second.

Generally, lower frame rate for any type of animation is considered inferior compared to higher frame rate, as smooth animation with more different frames in one second are sometimes preferred in comparison to something that has a stuttering, jerky effect and repeated frames. And stop motion is no stranger to this criticism, as we see this traditional animation art form nearly disappearing from the industry and many animation studios would prefer utilizing digital animation as it is more convenient and practical to create animation content directly with the software inside computers and be able to manipulate between many different frame rates with

just a click of a button. The effort it takes to produce the animation for stop motion with a higher frame rate can be very burdening to some studios, especially with the amount of manpower and time it takes to produce even a single second of animation, from creating the props and puppets, setting up the lighting and making sure that each frame can transition smoothly from one to the next.

But because of the lower frame rate that produces stuttering in the movements, the lower frame rate of stop motion can effectively create an unnatural, almost uncanny effect which could contribute to adding a horror element to the atmosphere of the animation (Zhou, 2022). This could potentially be the reason why several stop motion animation films that have been released over the years are categorized within the horror genre, or at least contain some frightening imageries in their story, such as many of Studio LAIKA's films, Jordan Peele's *Wendell and Wild* (2022), and Guillermo del Toro's *Pinocchio* (2022). The unusual movements with the jarring, missing frames created from stop motion, along with the hand sculpted assets, causes discomfort to the eyes due to its strange, jerky motions which generates an unnerving feeling within the audience, thus adding to the creepy atmosphere that can add to the experience of the audience watching the film with related genre such as horror or surrealism.

Methodology

This research was designed to be qualitative. Content analysis was done through data collection and observation of animation video samples of various animated media. These samples were thoroughly analyzed frame by frame to investigate the frame rates that were used by the animation as well as studying the artistic style that the filmmaker chose to use as a visual aesthetic and whether it plays a role in the creating the atmosphere or mood of the scenes in the animation. The animated media that were mainly used to be dissected and inspected for their innovative uses of frame rates in animation were Sony's animated films, *Spider-Man: Into the Spider-Verse* (2018) and its sequel, *Across the Spider-Verse* (2023). Literature review was done on several past animated films and publications to analyze the history of different frame rate use across the animation field over the years since the inception of animation many decades ago.

There was a usage of diagrams and comparison of different frames to showcase the difference in the visual representation of the frames of the same animation with different frame

rates. The 2D animation was done with hand drawn technique on a digital illustration software with animation capabilities, Clip Studio Paint EX, and the 3D animation was created using the software, Autodesk Maya. A survey was conducted with participants online using Google Forms to collect the feedback on their preferences for frame rates for both the 2D traditional animation and 3D computer animation as well as to gather their personal opinions on frame rates and whether their opinions can correlate with each other.

Spider-Man: Into the Spider-Verse

In the film, Spiderman: Into the Spider-Verse, most of the scenes were generally animated with a lower frame rate at 12 FPS, which gives it a more stop motion feel especially when animating in 3D. This was uncommon in comparison with the visual style of other animated films in 3D which usually opts for 24 or even 30 FPS for a smoother look to the movement of the characters and camerawork. But the directors and filmmakers of the film, Christopher Miller and Phil Lord wanted a completely different visual style to evoke a comic book feel to the entire film, how the pages of a comic book would flip as the story progresses, thus leaning towards the lower frame rate choice of 12 FPS for the majority of the film to enhance the traditional feel of the animation that evokes the feel of the comic book (Campbell, 2023). With lesser frames, the animators are able to focus on creating strong keyposes, which helps to enhance the strong action and motion to the audience's eyes, keeping them focused and captivated with the many action scenes that are prevalent in this specific genre. The lesser frames in the animation also provides an adrenaline rush as the audience is not too relaxed with smooth motion but rather, stepped frames with no transition between them, forcing them to focus as to not miss any moment.

In addition, the film also plays around with the concept of multiverses, which means the existence of more than one universe in a lifetime. This idea allows the creative freedom for the concept artists and the animators to experiment with different visual styles, such as modern Japanese anime, classic 2D animation of the Looney Toons era, and black and white noir style. This style and animation experimentation is further expanded in the sequel of the film, Across the Spider Verse. Characters like Peni Parker, a girl that came from a universe that intentionally showcases a Japanese anime style, and Spiderham, a Spiderman variant that is meant to display the older era of animation, are actually 3D models rendered in a 2D style. The animators tend to animate these characters in 12 FPS to reflect the 2D animation style, and the other characters that have a more 3D rendering to them also mirror these frame rates so that the difference in the

animation is not too noticeable and distracting, as too many different frame rates in one scene could cause uneasiness towards the audience and downgrade their enjoyment of the story.



Figure 6-8 The 2D Flat Rendering Styles of Different Characters in the Film into the Spider-Verse, Emulating a 2D Style of Animation

The animators had experimented with different frame rates playing in the same shot within the scene, with the purpose of displaying the different personality of the characters, especially in the context of a film where superheroes are gathered in one universe and each possessing different levels of skill sets. This is especially obvious to differentiate the experiences between the main character, Miles Morales, and his mentor, Peter B. Parker. In one scene, when Miles and Peter were escaping from a lab after acquiring the object that they needed, they were forced to swing on the trees in the forest nearby to escape one of the villains who was pursuing them, Doc Ock. Miles at this point in time was inexperienced at being Spiderman so the animators animated him with 12 FPS, making his movement a bit more jarring and staccato-like. The missing frames of a regular 24 frames per second emulated the lack of skills that Miles have, whilst Peter, the older Spiderman with more experience, was animated with a higher frame rate (24 FPS), which allows him to have a smoother look to his motion while he is swinging in the air. As Peter guided and taught Miles to swing in the air, Miles' animation frame rate slowly matches to Peter's 24 FPS, allowing us as the audience to see the progression of Miles into a more experienced Spider-Man.



Figure 9-10 From One Shot, Miles in the First Picture is Animated with a Lower Frame Rate at 12 FPS and When He Joins Peter in the Second Shot, He Swings in the Same Speed and Rhythm as Peter and has a Higher Frame Rate at 24 FPS

Spider-Man: Across the Spider-Verse

With the success of the first film in the franchise, the sequel, *Across the Spider-Verse* demanded more creative artistic visuals that the first one had revolutionized with 3D animation with lower frame rate. They had the same formula, using lower frame rate to animate their characters in 3D for the most part, trying to mimic the comic book feel and to match with the 2D rendering and compositing that the post-production team had applied to the overall look of the film. Each universe that exists in this film had their own different style of rendering and visual look, from Gwen's abstract, watercolour, painting aesthetic with a lot of pink and purple hues to the bright colours of Indian Spiderman to reflect his colourful Indian culture and aesthetic.

One of the breakthroughs that were really prominent from this film was the introduction of a character named Hobie, who also goes by his alias, Spider-Punk. As the name indicates, this character, originating from the UK in his world, embodies punk culture that was prevalent in Britain, a life with an anarchist attitude and going against what the system had established. The way he was animated very much reflects this idea as well. The animators also had an idea to animate him in a chaotic way to reflect how the multiple universes are colliding with one another, so several parts of him were animated in different frame rates to reflect the chaotic nature of the character as well as the ideology that he believes in (Failes, 2023).

According to one of the animators who worked on Hobie in the film, Li Wen Toh demonstrated with a diagram on how Hobie's character was set up to be animated in one scene within the film. Aside from the base character model, Hobie also came with special effects that emulates paper cut-outs from magazines that encapsulates the scrapbook, patchwork art style that goes hand in hand with the attitude and personality of Hobie in the film. In terms of the animating process itself, the animators took a long time to work a formula to create a

combination of different frame rates that mix together well. Overall, Hobie was animated with on twos (12 FPS) for some parts of his body, threes (8 FPS) for his overall animation and fours (6 FPS) for his iconic jacket, and his prop, the guitar, has the lowest frame rate, which was animated on sixes.



Figure 11 Hobie, a.k.a. Spider Punk in the Across the Spider-Verse Film, with a Rendering Style that Mimics the Magazine Cut-out Style and Erratic Movements with the Differing Frame Rates

Hobie's render style, though sometimes would have some changes for a few frames here and there in one scene, does not deviate too much from the original visual look that was assigned to him, so that whenever Hobie would be in a scene with other characters, his presence would not be too distracting and take away from the focus of the scene of any other characters, as his unusual movements due to his differing frame rates would have been enough to grab attention on his unique style. The final result portrays Hobie visually as someone who is unconventional, a rule breaker and not conforming to the standards that have been set by the system. Through the eyes of the audience, the constantly changing frames of individual parts of this one character, in addition to the style of magazine cut-outs that his appearance plays off can be jarring and jumbled to look at, giving a sense of inconsistency and chaos inside the audience's mind, but also keeps their focus on this particular character, and making him stand out and thus, reflecting his personality as well.

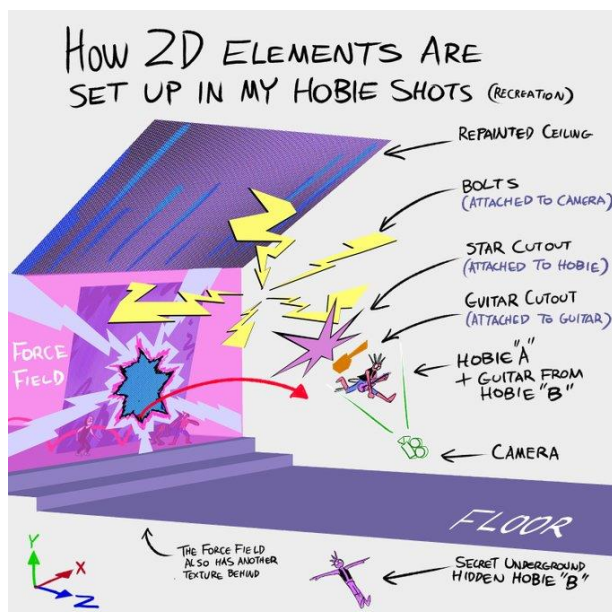


Figure 12 Image Courtesy of Li Wen Toh on his Twitter Page, Demonstrating the Setup and Rig that is Needed for the Animating Process for Hobie in One of the Scenes in the Film

Preference of the Audience for 2D and 3D Animation

For this research, a short survey was conducted to gather feedback from random participants online, collected from social media such as Twitter, Facebook, LinkedIn and Instagram. The survey was created with Google Form, and the content is about their preference of frame rates for the style of 2D and 3D animation. Responses from 35 participants have been collected for the duration of three days and a majority of 51.4% of the participants are in the age range of 26 to 35 years old, with 81.7% being from Malaysia and others from various countries like the United States, New Zealand and Tanzania. 68.6% comes with experience in working in animation, bringing their knowledge to the answers they provide and nearly 65.7% of them watch animation regularly.

For this sake of the survey, a simple 3D walk cycle animation was created in Autodesk Maya, rendered from the side view using a free downloadable rig named Lou, and then rendering it in three different frame rates but within the same duration of time: 12 FPS, 24 FPS and 60FPS. Additionally, a 2D hand drawn animation was created in the software, Clip Studio Paint EX, and rendered in two different frame rates: one being the original frame rate it was animated in, 24 FPS and the other was rendered in a lower frame rate which was 12 FPS. The survey also inquired about their perspective and opinions on the usage of different frame rates for both styles of animation.



Figure 13 Comparison of the Progression and Numbers of the Frames of the 3D Animation Based on Each Frame Rate, 12 FPS, 24 FPS and 60 FPS Respectively

Based on the figure, it can be concluded that the highest frame rate of the animation, 60 FPS can show a smoother progression of the movement based on the spacing of each frame, which is very minimal, whilst 12 FPS shows a wider gap between each frame, thus creating a more jumpy style of animation that has low smoothness and progression. However, based on the responses collected from the participants in the survey, a majority of them, which constitutes 51.4% of the overall participants preferred the middle ground of the frame rate, which is the standard 24 FPS, whilst the second highest percentage, 28.6%, is 60 FPS with the smoothest playback of the animation and the least preferred was 12 FPS with 20% preferring the more unconventional, choppy motion in the animation.

A majority of 82.9% of the participants inferred that there can be a choice to use a different frame rate than the standardized setting for the 3D animation, for either technical or artistic reasons. When asked about the reasoning, several of the participants elaborated that in terms of technical reasons, lower frame rate usually is a better choice for economical purposes as the computer used to render the frames would have less frames to render, thus saving time in production. From the perspective of the animating process, having more frames enables the

animators to apply the 12 principles of animation much easier as they have more frames to work with. However, most of the participants would agree that there would be exceptions in cases where 3D animation can be animated in 12 FPS, as most are influenced by the artistic style of the Spider Verse films over the past few years and that the low frame rate gives a traditional comic book feel to the animation, as well as emphasizing the important dynamic key poses during many of the action scenes expected from a film about a superhero.

In terms of how this affects the psychology of the audience itself, most participants don't have a concise or in depth explanation on the process itself, but rather, many of them talked about how pleasing higher frame rate would be towards the eyes of the audience when watching the animation play out on screen as the movements are much smoother and easier to process. In addition, having more frames shows smoothness in the movements which indicates confidence in the character, as stated by one participant. However, most would agree that low frame rate for 3D animation isn't necessarily bad to watch as an audience as it can play a significant part in storytelling, or implicate a favourable visual look to the audience, especially those who prefer more janky movements with stronger and more memorable poses that stays longer inside the minds of the audience, as opposed to a higher frame rate which has too many frames to process.

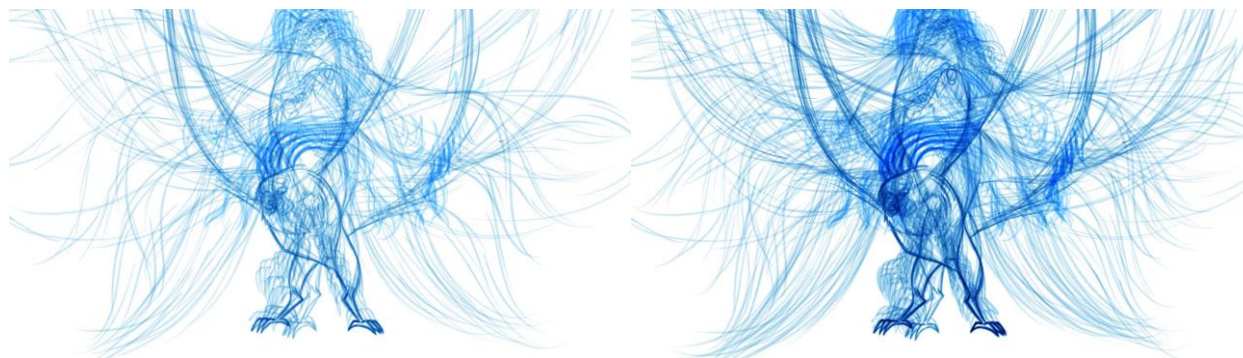


Figure 14 Comparison of the Progression and Numbers of the Frames of the 2D Animation Based on two Frame Rates: 12 FPS and 24 FPS Respectively

As for 2D animation, similarly to the 3D animation, the progression of the movement between each frame is much smoother and is more condensed in terms of spacing for the higher frame rate of the two, which is the 24 FPS. With 12 FPS, there is a bigger gap between the frames, thus creating more jumps and choppy effects. However, based on the result of the

survey, the result for the preference of the frame rate for 2D animation is divided almost equally among the participants, with 54.3% preferring 12 FPS and 45.7% preferring 24 FPS, while for whether which frame rate for 2D animation is better in general, they are similarly divided on the matter, with 51.4% preferring high FPS and 48.6% choosing low FPS.

For their explanations, most would agree that because 2D animation is a hand drawn art form that requires more time to produce one frame, the efficient frame rate to stick with would be 12 FPS, as it would be time saving and cost reducing for production companies. Moreover, 2D animation's limited animation does project a nostalgic charm from the older animation era of Looney Tunes and rubber hose animations back in the times where the animation industry has made its mark more in the entertainment world, so audiences today have gotten used to a lower frame rate for hand drawn animation in general, as visible in many animation series production. Higher frame rate would sometimes create too much fluidity and hyperrealism in traditional hand drawn animation which sometimes are too distracting for the enjoyment of the audience, as it can contribute to an uncanny and unnatural appearance to the audience's eyes compared to what they are used to. However, this doesn't necessarily equate to higher frame rate having no place with 2D animation, as a scene with a slower action or requires more elegant movements, like a dancing scene can utilize the higher number of frames because the audience can process the movements much better with more frames displayed on screen.

For the concluding section for the survey, the participants were asked whether the utilization of different frame rates can affect the audience's emotion while watching the scene. 88.6% percent of the participants had a definite agreement that the frame rates can influence the audience. Some commented that animators should take advantage of the different frame rates to apply during different scenes or shots to establish different types of atmosphere or vibe, depending on what was needed. Lower frame rates with less frames per second are preferable for a scene with dynamic actions and key poses, such as any scenes with fighting or chase sequences, while higher frame rates enables the pacing of the animation to slow down as the audience can see more details of the movement within the one second, thus signifying the importance of the moment. But a consensus was reached that the animators need to be consistent with the usage of the frame rate, so the ideal decision which is agreed upon is to stick with one frame rate for the majority of the animation, and possibly switching to a different one if the scene requires a change in the emotion, pacing or atmosphere of the story.

Conclusion

While frame rates are standardized for different types of animation according to what is necessary and efficient for production, as well as it being the norm that the audience who consume those animations frequently have been accustomed to, the artistic liberties taken by several production over the years have opened more doors to the experimentation of different frame rates in their animated projects. For 3D animation, this is not more apparent than the film *Spider-Man: Into the Spider-Verse*, which set an influential trend for the 3D animators to produce more animations in a lower frame rate, as can be seen clearly by several films and productions released prior to the film, such as *The Mitchells vs the Machines* (2021), *Puss in Boots: The Last Wish* (2022) and *Kizazi Moto*, a newly released anthology animated series on Disney Plus based on African cultures recently released in 2023. Lower frame rate style for 3D animation has been associated more with the visuals of graphic novels and comic books which can expand the creativity of the animators who work on these productions if they prefer the visual aesthetic of those concepts. It even gives the feeling of a stop motion animation, which might be to some animators' and audiences' taste, especially those who are familiar with it..

With stop motion, a method of animation that possesses several major limitations for production, lower frame rate could initially be assumed as something that would be a setback and takes away from the quality of the animation. However, having lower frame rate to the movements of the stop motion puppets can cause an unnatural looking effect which can contribute to the tone of the animation, which is why more often than not, stop motion has usually been tied with the horror, surrealistic genre that can benefit from the usage of low frame rates. With the popularity of stop motion animation rising with newer films such as *Wendell and Wild* and Guillermo del Toro's *Pinocchio*, the growth of the stop motion animation companies would allow for more usage of both lower and higher frame rate as they can allocate more time and manpower for an increase in production, in addition to having more advancements in the technology that can assist in creating these stop motion animations.

Additionally, traditional hand drawn animation which is more commonly referred to as 2D animation, have as much limitation with stop motion as well, since each frame has to be drawn and created separately, so for efficiency purposes, a low frame rate like 12 FPS is set as a standard frame rate. And the lower frame rate of traditional animation is always associated with fast action and comedic scenes like animations back in the older era, like *Looney Tunes* and

However, when a higher frame rate is applied to traditional animation, it can transform the traditional, jumpy animation into motion with more fluidity and elegance, which can emphasize the emotion in certain scenes that require slower pacing and focus on the details of each frames.

Table 1 A summary of the usage of frame rates in relation to the psychology of the audience in different techniques of animation

Animation Techniques	Summary of Frame Rate Use Correlation with Psychology
3D	Lower frame rate mimics a comic book or stop motion effect and enhances the strong key poses for action scenes to make it more memorable and keep the focus of the audience better. Higher frame rate of 24 FPS is standard and the most preferable, middle ground setting which is the most comfortable for the audience's eyes. Highest frame rate of 60 is usually used for video games to simulate real life motion and ensure a high quality experience for video game players to be more immersed in the gameplay.
2D	Similarly to 3D, lower frame rate makes a stronger impression for action scenes as it can focus on important key poses and remains stronger in the audience's memories. Higher frame rate can be used to show smoother movement and focus more on details that might be lost with lower frame rate such as small facial gestures which increases relatability towards the audience.
Stop Motion	Similarly to 2D animation, usually animated with a lower frame rate due to production costs. The low frame rate together with the sculpted look ends up creating a jarring movement that can make the audience feel more uncomfortable which is suitable for the horror genre or anything relevant.

At the end of the discussion, the choice on which frame rate to use for certain productions is entirely the decision of those who are creating these animations, especially with multiple constraints and limitations like time, technology and manpower, or to ensure the movements of the animation are smooth and fluid. But by understanding how different frame rates can contribute to different types of emotions towards the audience and atmosphere that is needed in the scene within the context of the animation, animators do not have to conform to the standard frame rates that have been set by the industry and are free to experiment with varying frame rates, and consequently, expand their creativity and imagination into creating more stylistic and unique works of animation, in addition to instilling different types of emotions within the audience by affecting their psychology while viewing these animations.

References

- [1] Allison, A., (2021, October 28). *The Thief and the Cobbler: The Greatest Animated Movie Never Made*, Collider, <https://collider.com/the-thief-and-the-cobbler-history-explained/>
- [2] *Animation and subjectivity : towards a theory of framerate modulation*, (May 17, 2020) Animétudes, <https://animetudes.com/2020/05/17/animation-and-subjectivity-towards-a-theory-of-framerate-modulation/>

- [3] Armstrong, M., Flynn, D., Hammond, M., Jolly, S., Salmon, R., (2008), *High Frame-Rate Television*, BBC White Paper WHC 169
- [4] Campbell, K., (2023, June 7), *Why the Spider-Verse films are the greatest comic book movies ever made*, BBC, <https://www.bbc.com/culture/article/20230606-why-the-spider-verse-films-are-the-greatest-comic-book-movies-ever-made>
- [5] Crafton, D., (2012) *Shadow of a Mouse: Performance, Belief, and World-Making in Animation*, University of California Press
- [6] Desai, A., (2022, November 7), *Breaking Down the Making of Spider Man: Into the Spider-Verse*, postudio, <https://www.postud.io/blog/spider-verse-breakdown/>
- [7] Failes, I., (2023, June 17), *The 'Across the Spider-Verse' Spider-Punk character Hobie was animated with different frame rates for different parts of his own body and accessories*, Before and Afters, <https://beforesandafters.com/2023/06/17/the-across-the-spider-verse-spider-punk-character-hobie-was-animated-with-different-frame-rates-for-different-parts-of-his-own-body-and-accessories/>
- [8] Frank, H., & Gunning, T. (2019). *A View of the World: Toward a Photographic Theory of Cel Animation*. In D. Morgan (Ed.), *Frame by Frame: A Materialist Aesthetics of Animated Cartoons* (1st ed., pp. 44–73). University of California Press.
- [9] Khalil, S. H. M., Ghani, D. A., (2018) *The Study of Differences and Similarities Between Ghibli Studio and Kyoto Animation*, Journal of Engineering and Applied Sciences, 13 (21), 9121 - 9131
- [10] Lamotte, C. (2022). *Discovering Animation Manuals: Their Place and Role in the History of Animation*. *Animation*, 17(1), 127–143
- [11] Maselli, V., (2018). The Evolution of Stop-motion Animation Technique Through 120 Years of Technological Innovations. *International Journal of Literature and Arts*. Vol. 6, No. 3, 2018, pp. 54-62
- [12] Pazhoohi, F., Kingstone, A., (2021). *The Effect of Movie Frame Rate on Viewer Preference: An Eye Tracking Study*, *Augment Hum Res* 6, 2 (2021)
- [13] Siyao, L., Zhao, S., Yu, W., Sun, W., Metaxas, D. N., Loy, C. C., Liu, Z., (2021). *Deep Animation Video Interpolation in the Wild*, *Computer Vision and Pattern Recognition 2021*
- [14] *The Difficulty of Animation and Being Mindful of the Industry*, (April 2, 2023) Japanpowered, <https://www.japanpowered.com/anime-articles/the-difficulty-of-animation-and-being-mindful-of-the-industry>
- [15] Walter, K., (1975). *The Silent Clowns*, New York: Knopf

- [16] Williams, R., (2009). *The Animator's Survival Kit--Revised Edition: A Manual of Methods, Principles and Formulas for Classical, Computer, Games, Stop Motion and Internet Animator*, Faber & Faber, Inc.
- [17] Zhou, S., (2022, September 19), *Should the Low Frame Rate of Stop-motion Animation Be Regarded as a Defect?*, Animationstudies 2.0, <https://blog.animationstudies.org/?p=4567>

Acknowledgements

I would like to thank Allah for still allowing me to breathe and live long enough to be able to submit this paper and acquire many new experiences and knowledge on my journey. I would like to thank my mother for always supporting me and remember my late father for reminding me of how much he had believed in me and what I can be capable of. I would like to thank my sister for encouraging me to pursue higher education alongside her PHD candidature and my brothers for being there always. I would like to thank my friends for always having my back and being there when I was at my lowest. I would like to thank my supervisor, Dr Vimala for being encouraging and helpful in my current period of study and the other postgraduate lecturers as well for their insightful advice. I would lastly like to give thanks to my colleagues for assisting me in my time at Multimedia University so far.

Funding Information

The author received no funding from any party for the research and publication of this article.

Author's Bio

Sharafina Teh is an assistant lecturer in Multimedia University, Cyberjaya, working in the Faculty of Creative Multimedia and teaching animation and design subjects. She has eight years of experience in the animation industry, working as a 3D animator and storyboard artist for various projects, promoted to lead senior animator where she had the experience of reviewing and analyzing the other animators' works, as well as contributing to Natural Traveller Magazine, published and based in the USA as an illustrator and writer in her spare time.