
| RESEARCH ARTICLE**Analyses of Effective Use of Animation Principles in 2D, 3D and Stop Motion Animation****Emmanuel Rock Nyarko Hanson¹, Ralitsa Diana Debrah² ✉ Adam Rahman³, Martin Adi-Dako⁴ and Ismaila Moro⁵**¹*University of Education, Winneba, Ghana*^{2,3,4,5}*Kwame Nkrumah University of Science and Technology, Ghana***Corresponding Author:** Ralitsa Diana Debrah, **E-mail:** rddebrah.art@knust.edu.gh

| ABSTRACT

The paper seeks to ascertain how the animation principles are being effectively utilized in any digital animation production such as Two Dimensional (2D) animation, Three Dimensional (3D) animation and Stop Motion. The paper uses a qualitative research methodology to ascertain how effectively these animation principles are used and its impact on the total look of the film. Three movies selected for this exercise are: The Lion King (2D), Moana (3D) and Chicken Run (Stop Motion). The movies would be observed and analyzed to ascertain how effective the animation principles used and how each principle relates to the other as long as the golden rules of animation are concern. The paper concludes by either supporting the notion that these animation principles are indeed also called the Golden Rules of animation as being called by Disney animators and therefore are inevitable or an animation on the other hand can be produced to satisfy its targeted audience without the effective uses of the animation principles.

| KEYWORDS

Animation Principles, Golden Rules, Design Principles, Design Elements, Classical Animation, Two Dimensional Animation (2D), Three Dimensional Animation (3D), Stop Motion, Computer Generated Image (CGI).

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1. Introduction

Animation relies fundamentally on the effective manipulation of lifeless objects to communicate intent, emotion, or create narrative meaning. Since their formal articulation by Frank Thomas and Ollie Johnston in 1981, have been the back bone animators rely on to achieving classical motions. Animation is a captivating art form that has the power to bring characters, stories, and worlds to life in ways that transcend reality. An object is able to convince audience as it can move on its own and also inhibits the attributes of character and personality as a result of the effective used of the animation principles. Behind the magic of animation lie fundamental principles and techniques that form the backbone of the animated storytelling process. These principles, honed over years of practice and innovation, serve as the guiding light for animators, helping them create compelling and engaging narratives that resonate with audiences of all ages.

Animation differs from live-action cinema in that motion must be deliberately constructed rather than captured. This responsibility places emphasis on principles that govern timing, weight, anticipation, and expressive clarity. The Twelve Principles of Animation emerged from decades of studio practice and continue to underpin animation

production regardless of technological advancement. This paper explores their application across multiple animation forms.

Animation as a medium of expression can be seen used in different fields such as medical, advertising, film, game, web, architecture and engineering. This paper examines the continued relevance and application of these principles through a comparative analysis of *The Lion King* (2D), *Moana* (3D), and *Chicken Run* (stop-motion). The study demonstrates that while technical execution varies across media, the principles remain indispensable to achieving believable motion and audience engagement.

1.1 The Early Evolution of Animation: From Prehistoric Visual Narratives to Contemporary Digital Practice

The origins of animation can be traced far earlier than the advent of modern cinema, extending back to prehistoric visual practices in which early humans attempted to depict motion, narrative, and causality through static imagery. Cave paintings discovered in sites such as Lascaux (France) and Altamira (Spain), dated between 17,000 and 30,000 years ago, frequently show animals with multiple overlapping limbs or repeated body positions, suggesting an intentional effort to represent movement over time (Thomas & Johnston, *The illusion of life: Disney animation*, 1981); (Solomon, 2011). These visual strategies are widely interpreted as early attempts at motion depiction and narrative sequencing.

Anthropological interpretations suggest that such images were often associated with sympathetic magic, a belief system in which representing an event visually such as a successful hunt was thought to influence real-world outcomes (Gombrich, 2002). While these images were static, the repetition and superimposition of forms introduced the foundational concept of persistence of vision, a perceptual phenomenon that would later become central to animation and motion picture technologies.

2. Optical Devices and the Birth of Illusory Motion

The formal exploration of motion illusion gained scientific and technological momentum in the nineteenth century, driven by curiosity about human vision and perception. Several optical devices emerged during this period, each contributing incrementally to the development of animation as a systematic practice.

The Magic Lantern (c. 1650, popularized in the 18th–19th centuries)

Although predating most animation devices, the Magic Lantern is significant as one of the earliest image-projection technologies. Developed by Christiaan Huygens in the seventeenth century, it used a light source, glass slides, and lenses to project images onto walls or screens (Theater, 2018). By manually changing slides or using mechanical slides with moving parts, presenters could simulate rudimentary motion such as ghosts floating or figures transforming (Mannoni, 2000). While not animation in the modern sense, the Magic Lantern introduced projection, sequencing, and audience-based visual storytelling key foundations of animated cinema.

The Thaumatrope (1825)

The Thaumatrope, invented by John Ayrton Paris, consisted of a disc with different images on each side attached to strings. When spun rapidly, the images appeared to merge into a single composite image due to persistence of vision, for example, a bird appearing inside a cage (Productions, 2026). Though extremely simple, the thaumatrope demonstrated a crucial perceptual principle: that the human eye retains images briefly, allowing separate visuals to fuse into a unified experience (Crafton, 1993).

The Phenakistoscope (1832)

The Phenakistoscope, developed independently by Joseph Plateau and Simon von Stampfer, was among the first devices to create a convincing illusion of continuous motion. It consisted of a rotating disc with sequential images viewed through slits while facing a mirror. As the disc spun, the images appeared to animate smoothly. This device introduced frame-by-frame sequencing, a core concept that remains fundamental to all animation techniques, including 2D, 3D, and stop-motion animation (Wells P. , 1998).

The Zoetrope (1834)

The Zoetrope, invented by William George Horner, refined the principles of the phenakistoscope by placing image strips inside a cylindrical drum with vertical slits. Unlike earlier devices, it allowed multiple viewers to observe the animation simultaneously. The zoetrope further advanced the idea of cyclic motion and continuous loops, concepts still evident in modern walk cycles and looping animations (Bendazzi, 2016).

The Flipbook (1868)

The Flipbook, patented by John Barnes Linnett as the “kineograph,” offered a portable and intuitive means of animation. Sequential drawings placed on the edges of a book could be animated by rapidly flipping the pages. The flipbook directly established the animator’s workflow of drawing discrete frames that create motion when viewed in succession. This principle maps directly onto contemporary digital timelines and frame-based animation software (Williams, 2009).

The Praxinoscope (1877)

Invented by Émile Reynaud, the Praxinoscope improved upon the zoetrope by replacing slits with a ring of mirrors placed at the center of the device. This innovation reduced image distortion and flicker, producing smoother and brighter motion. Reynaud later expanded this invention into the Théâtre Optique, which allowed longer animated narratives to be projected to audiences arguably marking the transition from optical toys to animated storytelling (Mannoni, 2000).

2.1 From Optical Devices to Traditional Animation

The principles established by these devices sequential imagery, timing, spacing, and visual continuity were later formalized into traditional hand-drawn animation and cel animation in the early twentieth century. The introduction of transparent celluloid sheets allowed characters to be animated independently from backgrounds, significantly increasing production efficiency and visual consistency (Solomon, 2011).

Pioneers such as Walt Disney, along with animators Frank Thomas and Ollie Johnston, refined animation into a sophisticated art and industry. Their articulation of the Twelve Principles of Animation, first documented in *The Illusion of Life* (1981), codified centuries of perceptual experimentation into a practical framework that continues to guide 2D, 3D, and stop-motion animation today. These principles represent a direct intellectual lineage from early optical devices to contemporary digital animation workflows.

3. Types of Animation

3.1 Two-Dimensional (2D) Animation

Two-dimensional (2D) animation represents the earliest formalized mode of animation practice and remains one of the most enduring forms of animated visual communication. Historically, 2D animation evolved from hand-drawn sequential imagery on paper and celluloid sheets into digitally assisted production pipelines, making it a versatile medium for entertainment, education, advertising, and visual storytelling (Hanif, Negara, & Astuti, 2022). Fundamentally, 2D animation operates within a planar coordinate system defined by the horizontal (X) and vertical (Y) axes, a conceptual framework that underpins its spatial logic and visual construction (Foley, van Dam, Feiner, & Hughes, 2014).

The simplicity of the two-dimensional plane has enabled 2D animation to remain relevant across multiple disciplines beyond entertainment. In game development, for instance, 2D games continue to thrive due to their computational efficiency, stylistic clarity, and strong emphasis on gameplay mechanics rather than spatial realism (Zhang, Prakash, & Sung, 2004). Similarly, in educational contexts, 2D coordinate systems form the foundation for teaching mathematical visualization, spatial reasoning, and graphical representation, despite challenges learners often face in interpreting precise spatial relationships within grids (Foley, van Dam, Feiner, & Hughes, 2014).

Beyond creative and educational applications, 2D spatial frameworks have also been explored within theoretical physics. Studies on two-dimensional Lorentz transformations demonstrate how motion and relative velocity affect perceived dimensions within constrained spatial systems, revealing the broader scientific relevance of planar

representations (Khadka, 2024). Collectively, these perspectives highlight the wide-ranging applicability of two-dimensional systems, reinforcing their conceptual and practical importance across disciplines.

Although the rise of three-dimensional (3D) animation has expanded visual realism and spatial depth, 2D animation retains unique artistic and economic advantages. It is generally less resource-intensive and allows for greater stylistic control over character design, motion exaggeration, and symbolic expression (Du, 2021). Iconic character features such as the consistently circular ears of Mickey Mouse illustrate how 2D animation preserves design clarity that can be compromised when translated into three-dimensional space (Barbieri, Jiang, Cawthorne, Xiao, & Yang, 2018).

Contemporary animation increasingly blends 2D and 3D techniques to exploit the strengths of both forms. A notable example is *Spider-Man: Into the Spider-Verse*, which revolutionized animation aesthetics by integrating hand-drawn 2D line work, stylized textures, and painterly effects within a 3D rendering pipeline. This hybrid approach required the development of novel compositing tools and procedural line-generation systems that allowed artists to maintain expressive freedom while preserving underlying animation consistency (Davignon & St. Clair, 2023); (Grochola, Maccari, Lee, & Boulet-Gilly, 2023). Such innovations have challenged conventional animation workflows and expanded the expressive potential of animated feature films (Hoffman, 2019).

3.2 Stop-Motion Animation

Stop-motion animation is a frame-by-frame animation technique in which physical objects are incrementally manipulated and photographed to create the illusion of movement (Tziarou, Manavis, Efklidis, & Kyratsis, 2024). Unlike purely digital animation, stop motion derives its visual strength from the physicality and tactile presence of real-world materials, resulting in an aesthetic characterized by texture, imperfection, and handcrafted authenticity (Yekti, 2017).

Traditionally, stop-motion production involves detailed pre-planning, including pose reference drawings and exposure sheets, followed by meticulous object manipulation and photographic capture (Wishart, 2017). This labor-intensive process contributes to the medium's distinctive visual charm but also presents significant production challenges, including extended timelines and higher costs when compared to 2D and 3D animation techniques (Yekti, 2017).

Despite these constraints, stop-motion animation has retained cultural and artistic relevance, particularly through studios such as Laika, which have successfully integrated digital technologies including 3D printing, facial replacement systems, and digital compositing into traditional puppet-based workflows (Halim, Hamid, Zainuddin, Herman, & Irwandi, 2021). These hybrid approaches enhance production efficiency while preserving the medium's tactile qualities.

Recent research has also explored environmentally sustainable practices in stop-motion production, such as the use of recycled materials for sets and puppets, addressing both ecological concerns and cost efficiency (Liu, Huang, Qin, & Lin, 2024). Additionally, experimental methodologies blending 2D digital animation, 3D modeling, and paper-based construction have emerged, enabling low-poly stop-motion workflows that bridge digital design and physical realization (Ayres, 2020).

Although stop motion occupies a smaller share of the global entertainment market relative to 2D and 3D animation, its enduring appeal is evident in acclaimed productions such as *Chicken Run*, *The Nightmare Before Christmas*, *Coraline*, *Kubo and the Two Strings*, and *The Little Prince*. These works demonstrate the medium's continued relevance as a powerful storytelling form rooted in material authenticity and artistic craftsmanship.

3.3 Three-Dimensional (3D) Animation

Three-dimensional (3D) animation operates within a volumetric spatial system defined by three orthogonal axes: X (width), Y (height), and Z (depth). This additional dimension introduces volume, spatial depth, and physical form, enabling objects to be represented and manipulated as entities occupying real or simulated space (Orelaja, Musa,

Badmos, & Adeleke, 2021); (Tversky, Morrison, & Betrancourt, 2002). In computer graphics, 3D animation involves the creation of virtual models and the generation of motion through computational processes that simulate the physical behavior of objects, lighting, and materials (Pharr, Jakob, & Humphreys, 2017).

Unlike 2D animation, 3D animation emphasizes spatial realism through perspective, physically based shading, and realistic motion dynamics. Although rendered images ultimately appear on two-dimensional screens, they convey the illusion of three-dimensionality through depth cues, camera movement, and lighting interactions (Afif, 2023). Advances in interaction design have further expanded 3D animation into immersive domains, allowing users to navigate, select, and manipulate objects within virtual environments (Orelaja, Musa, Badmos, & Adeleke, 2021).

The historical development of 3D animation is closely tied to advancements in computer technology. The field traces its origins to Ivan Sutherland's Sketchpad (1963), which introduced interactive computer graphics and laid the groundwork for modern modeling systems (Sito, 2013). Subsequent innovations in motion capture, rendering algorithms, and display technologies propelled 3D animation into mainstream film production (Power, 2009).

A defining milestone in the evolution of 3D animation was the release of *Toy Story* (1995), the first fully computer-generated animated feature film produced by Pixar Animation Studios. The film set a new benchmark for CGI production, demonstrating the viability of 3D animation for feature-length storytelling (Wells P. &. 2008). Produced over four years using Silicon Graphics workstations, *Toy Story* showcased unprecedented levels of character believability, lighting realism, and narrative integration (Porter & Susman, 2000).

The commercial success of *Toy Story* grossing over \$360 million worldwide catalyzed rapid industry adoption of 3D animation technologies and reshaped global entertainment markets (Bendazzi, 2016); (Studios, 2024). Subsequent films such as *A Bug's Life*, *Finding Nemo*, *Frozen*, *Zootopia*, and *Coco* further advanced lighting, shading, and simulation techniques, solidifying 3D animation as a dominant force across film, gaming, architecture, medicine, education, and simulation (Magenat-Thalmann & Thalmann, 2014); (Orelaja, Musa, Badmos, & Adeleke, 2021).

Today, 3D animation constitutes a multibillion-dollar global industry, driven by continuous technological innovation and expanding application domains. While realism has historically dominated 3D animation aesthetics, contemporary practice increasingly embraces stylization and hybrid approaches, reflecting a convergence of artistic expression and computational sophistication.

4. Continuity into Contemporary Digital Animation

Modern animation technologies whether 3D computer animation, motion capture, or real-time rendering remain fundamentally grounded in the perceptual discoveries made during the nineteenth century. Despite advances in software, hardware, and rendering techniques, the illusion of motion still depends on the same core ideas: frame sequencing, timing, anticipation, and visual continuity. Thus, contemporary animation is not a departure from early practices but rather an extension and refinement of them.

4.1 The Twelve Principles of Animation

1. Squash and Stretch

Squash and stretch describe the deformation of objects or characters to emphasize weight, mass, speed, and flexibility. While exaggerated deformation enhances expressiveness, volume consistency must be maintained to preserve believability (Thomas & Johnston, *The illusion of life: Disney animation*, 1981). This principle is prominently visible in character movement, facial expressions, and physical reactions across all three films, although executed differently depending on the animation medium.

2. Anticipation

Anticipation prepares the audience for an impending action, making movement appear natural and readable. For instance, a character crouching before a jump signals intent and builds momentum. Without anticipation, actions

appear abrupt and mechanically implausible (Williams, 2009). Anticipatory gestures are especially pronounced in 2D animation but remain essential in 3D and stop-motion contexts.

3. Staging

This is the presentation of any idea so that it is completely and unmistakably clear. This is a broad principle because it encapsulates many animation principles. This can be applied to acting, timing, camera angle and position as well as setting. This basically leads the audience eyes and attention to a particular spot within the shot (Ahmad Ridhwan Bin A Samad, 2017). A good staged character action focuses on the character, camera follows the character or subject from one point to another to tell a story. Good staging quickly and easily sends the message to the audience and also makes the audience anxious and curious about what will happen next. Camera shots are equally important during staging, for instance, a full body action is best captured by a Long Shot (LS) while a facial expression action is best captured with Close Up (CU) (Fadila, Hassan, Arkan, & Indaru, 2024). The effective implementation of the rule of third (ROT) is equally important during staging. Proper timing is also important, it's better to time your action sequentially than overlapping them simultaneously. Proper poses are really useful in staging, like a scene dating around the 1960's will best be dressed with assets that were predominantly during that era than stuffing it with modern assets or props (Widadijo, 2020).

4. Straight Ahead Action and Pose-to-Pose

This term basically describes two methods of animation via drawing. Straight ahead as the name implies is drawing sequentially from one pose, then followed by the next progressively. Pose to pose on the other hand is where the extreme poses or block poses are drawn followed by the in-betweens, and then the final drawings which are the break downs blending everything together. Straight ahead is faster to animate but usually results in distorted outcomes whereas pose to pose takes time but produces the best result. Unpredictable animations such as fire, water simulation, explosion are best animated using straight ahead technique. Secondary actions too are best handled by pose to pose (Williams, 2009).

5. Follow-Through and Overlapping Action

This is where we have some body parts and appendages follow the main subject in an uncontrolled manner. Follow through basically refers to the part of the body or a costume that continues to move for a while after the body or subject action stops. Overlapping action describes the offset between the timing of the main body and the attached part. Drag which is very essential to this is responsible for the delay in time of movement of these appendages or body parts. These collectively add a great deal of realism to a character's action (Becker, 2017); (Thomas & Johnston, *The illusion of life: Disney animation*, 1981).

6. Slow In and Slow Out

Natural motion rarely begins or ends abruptly. Slow in and slow out ensure that actions accelerate and decelerate gradually, enhancing organic movement. Proper spacing between frames determines whether motion appears smooth or mechanical (Kerlow, 2009).

7. Arcs

Most organic movements follow curved trajectories rather than straight lines. Arcs create fluid, natural motion, whereas rigid linear movement often signals mechanical or artificial behavior (Williams, 2009).

8. Secondary Action

This set of action relates to overlapping action though does not replace it. Secondary action describes gestures that support the main action to add more dimension to the character animation. Example, the main emphasis of a walking character is the legs, making the rest of the body secondary action. Principle of staging is also very important in secondary action. Another example is a character eating a burger. The primary action is the bite but licking his lips shows he is hungry, moreover, eye brows going up immediately after the bite shows he likes it then lastly shaking his head shows he cannot believe how good it tastes. Though the primary action is the bite all the rest are secondary actions and they add more dimensions to the bite (Becker, 2017).

9. Timing

The personality and nature of an animation is greatly affected by the number of frames inserted between each main action. This simply means less drawings or frames means fast motion and vice versa. The number of drawings or frames used in an animation tells a story about the subject of that given time. A leisure character walk will use 16 frames per second for a step while a happy character or excited character will use 12 frames per second for a step of walk cycle (Williams, 2009); (Becker, 2017).

10. Exaggeration

This throws more light on the pose, action or facial expression of a character. If a character is happy, an exaggerative part of him showing this expression becomes the notch that takes that action to the next level. Exaggeration however, does not mean more distorted but rather more convincing. Quick motions demands bigger exaggerations for them to be noticed and vice versa (Lasseter, 1987).

11. Solid Drawing

Solid drawing ensures that characters appear to have weight, balance, and volume within three-dimensional space. Although originally associated with hand-drawn animation, the principle remains relevant in 3D and stop-motion contexts through spatial consistency and physical plausibility.

12. Appeal

Appeal refers to the visual and emotional attractiveness of a character. Giving the character a dynamic design can boost the appealing nature of the character. The three steps of achieving appeal are:

- a. Use a variety of shapes instead of using the same shapes for every character.
- b. Play with proportion, example playing by scaling up some body parts such as the head, eyes or nose goes a long way to add more appeal to the character.
- c. Keep it simple; this means too much of information can ruin the character and makes it more difficult to work on the character (Williams, 2009); (Becker, 2017); (Lasseter, 1987) .

5. Research Design and Methodology

This paper investigates the role and significance of the Twelve Principles of Animation often referred to as the "Golden Rules of Animation" as articulated by Frank Thomas and Ollie Johnston in *The Illusion of Life* (1981). The study adopts a qualitative research design, using systematic visual observation as the primary data collection instrument to examine how these animation principles are applied in Three purposefully selected animated feature films: *The Lion King* (2D animation), *Moana* (3D computer animation), and *Chicken Run* (Stop-Motion animation).

Qualitative research is particularly suited to studies that seek to interpret meaning, form, aesthetics, and experiential qualities rather than numerical frequency or statistical generalization (Creswell & Poth, 2018); (Denzin & Lincoln, 2018). Animation principles operate within visual, temporal, and expressive domains, making them inherently difficult to quantify using numerical or experimental methods. As such, a qualitative approach allows for in-depth interpretive analysis of motion, performance, timing, and visual storytelling elements that are central to animation aesthetics but resist reduction to measurable variables.

Furthermore, animated films function as cultural and artistic texts, making them appropriate subjects for qualitative case study analysis (Stake, 1995); (Yin, 2018). By examining these animated films, the researcher was able to analyze animation principles as they appear in real production contexts.

Observation deemed the most appropriate data collection method for this study because the research objects which is animated films are visual artifacts whose qualities must be examined directly through careful viewing. Unlike surveys or interviews, which rely on participants' recollections or opinions, observation enables the

researcher to systematically analyze movement, timing, staging, and character performance as they appear on screen (Marshall & Rossman, 2016).

Additionally, animation principles such as squash and stretch, anticipation, timing, and appeal are embedded within motion and visual sequencing, making them unsuitable for enumeration or questionnaire-based measurement. Observation allows for repeated viewing, frame-by-frame analysis, and cross-comparison between animation styles, ensuring analytic rigor and interpretive depth (Rose, 2016).

The purposeful selection enabled comparative analysis across animation techniques, allowing the researcher to examine whether the Twelve Principles remain relevant and effective regardless of medium. Purposeful sampling was widely accepted in qualitative research when the goal is theoretical insight rather than statistical representativeness (Patton, 2015).

To manage the breadth of the Twelve Principles, they are organized into three analytical clusters, with each film examined using four principles. This structured allocation ensures depth of analysis while maintaining analytical focus.

6. The Lion King (1994)



Figure 1.0: The Lion King (Disney Movies)

6.1 Overview

The Lion King as shown in Figure 1.0 above is a landmark American animated musical drama produced by Walt Disney Feature Animation and released by Walt Disney Pictures in 1994. The film was directed by Roger Allers and Rob Minkoff, produced by Don Hahn, and written by Irene Mecchi, Jonathan Roberts, and Linda Woolverton. It features an accomplished ensemble voice cast including Matthew Broderick, James Earl Jones, Jeremy Irons, Jonathan Taylor Thomas, Moira Kelly, Nathan Lane, Ernie Sabella, Whoopi Goldberg, Cheech Marin, Rowan Atkinson, and Robert Guillaume (Hahn, 1994) ; (P., 1998). Narratively, The Lion King draws upon classical dramatic structures and mythic storytelling traditions, most notably Shakespeare's Hamlet and Joseph Campbell's monomyth or "hero's journey" framework (Campbell, 1949); (Wells P. &, 2008). The film follows the life of Simba, a young lion prince whose father, Mufasa, the reigning king of the Pride Lands, is murdered by his treacherous brother Scar in a calculated bid for power. Scar manipulates Simba into believing he is responsible for his father's death, leading to Simba's self-imposed exile. As Simba matures away from his homeland, he must confront his past, accept responsibility, and ultimately return to reclaim his rightful place as king, restoring balance to the Pride Lands (Hahn, 1994).

Upon its theatrical release on June 24, 1994, The Lion King received widespread critical acclaim for its narrative depth, emotional resonance, musical score, and high level of traditional animation craftsmanship. Critics particularly praised its thematic exploration of responsibility, identity, loss, and renewal, as well as its integration of character performance with expressive animation grounded in the classical Disney principles (Thomas & Johnston, The illusion of life: Disney animation, 1981); (Wells P. , 1998).

Commercially, the film achieved extraordinary success. It grossed approximately US\$763 million worldwide during its original theatrical run, making it the highest-grossing film of 1994 and, at the time, the second-highest-grossing film in cinematic history, surpassed only by Jurassic Park (1993) (IMDbPRo, 2026). The Lion King held the record as the highest-grossing animated film until the release of Finding Nemo in 2003. Importantly, it remains the highest-grossing traditionally animated (hand-drawn) feature film of all time, a distinction that underscores the enduring economic and artistic viability of 2D animation (Wells P. &, 2008).

The film also achieved remarkable success in the home entertainment market, becoming the best-selling home video title of all time, with over 55 million copies sold worldwide across Video Home System (VHS), (Digital Versatile Disc or Digital Video Disc) DVD, and Blu-ray formats (Wells & Hardstaff, 2008); (Wells P. , 1998). In terms of accolades, The Lion King won two Academy Awards which are Best Original Score and Best Original Song ("Can You Feel the Love Tonight") as well as the Golden Globe Award for Best Motion Picture, Musical or Comedy (Sciences, 1995).

Beyond its commercial and critical achievements, The Lion King is widely regarded as one of the greatest animated films ever produced. Scholars and practitioners frequently cite the film as a benchmark for effective character animation, visual staging, emotional storytelling, and the disciplined application of the Twelve Principles of Animation, often referred to as the "Golden Rules of Animation" (Thomas & Johnston, The illusion of life: Disney animation, 1981); (Wells & Hardstaff, 2008). Its sustained cultural relevance, continued academic discussion, and influence on subsequent generations of animators affirm its central place in both animation history and contemporary animation pedagogy.

6.2 Analytical review of four Animation Principles: The Lion King

This section evaluates The Lion King (1994) through four foundational animation principles: Squash and Stretch, Anticipation, Staging, and Straight Ahead versus Pose-to-Pose action. The objective is not merely to identify instances of these principles, but to analyze how their calibrated deployment contributes to fluidity, narrative clarity, character performance, and the preservation of classical 2D animation aesthetics. As one of the most commercially and critically successful traditionally animated feature ever, The Lion King represents a mature synthesis of Disney's

animation philosophy during the studio's renaissance era. Its animation demonstrates disciplined application of these principles at structural, performance, and cinematic levels.

6.2.1 Squash and Stretch: Elasticity and Organic Credibility

Squash and Stretch underpins the organic believability of motion throughout the film. The opening "Circle of Life" sequence immediately establishes elastic realism as animals traverse the landscape toward Pride Rock. Antelopes compress upon landing and elongate during upward propulsion; birds stretch during wing extension and compress during retraction; even elephants exhibit subtle mass compression as their weight shifts during locomotion.

Importantly, volume consistency is preserved. Forms deform but do not distort. This restraint prevents caricature and sustains anatomical plausibility, aligning the elasticity with biological realism rather than comedic exaggeration. The principle extends to character acting. Scar's elongated spine and compressed shoulders during his dismissive exit scene subtly communicate psychological duplicity. Young Simba's playful pounces display exaggerated compression and rebound, reinforcing youthfulness and kinetic immaturity. Even emotional states activate squash: fear compresses bodies inward; shock stretches facial musculature. In *The Lion King*, Squash and Stretch is not ornamental it is structural. It creates tissue-like flexibility, reinforces gravity interaction, and sustains fluid continuity across sequences.

6.2.2 Anticipation: Preparing the Eye and the mind of the audience

Anticipation functions as a temporal buffer that prepares the audience for an impending action. Its absence would render motion abrupt and mechanically disjointed.

In *The Lion King*, Anticipation operates at multiple scales:

Physical Anticipation

Before Simba leaps, he crouches. Before Rafiki hugs Mufasa, he opens his hands wide, with his body lowers and muscles tense. This pre-action compression informs the viewer of imminent force generation. The crouch and hug are not merely physical; but psychologically cues the audience.

Similarly, when Zazu attempts to take flight after confrontation, his wings briefly retract before expanding. That micro-delay prevents unnatural instantaneous motion.

Emotional Anticipation

Anticipation also functions dramatically. In the stampede sequence, subtle environmental stillness precedes chaos. Scar's calculated pause before initiating betrayal creates tension. His lowered voice and slowed gestures anticipate the climactic push that follows. The emotional beats are staged through pre-action hesitation, allowing narrative momentum to build before release.

Cinematic Anticipation

Camera movement itself anticipates action. During Simba's return as an adult, framing and wind direction shift before his first roar. The visual atmosphere prepares the viewer for reclaiming authority. Anticipation in *The Lion King* therefore operates kinetically, psychologically, and cinematically ensuring clarity and dramatic coherence.

6.2.3. Staging: Clarity of Idea and Visual Hierarchy

Staging ensures that the intended narrative focus is unmistakable. It governs composition, silhouette clarity, camera placement, and timing hierarchy.

Silhouette Integrity

Disney's classical 2D tradition emphasizes readable silhouettes. In *The Lion King*, major emotional moments Simba's hesitation, Mufasa's confrontation, Scar's plotting are composed in clean profile or three-quarter views that maintain gesture clarity. When Simba stands at the cliff edge, his posture is isolated against the sky. The staging prevents visual clutter and reinforces thematic rebirth.

Environmental Staging

The Pride Lands are color-coded to reflect power dynamics. Warm golden tones dominate scenes of harmony, while de-saturated green-gray palettes frame Scar's regime. Staging here is chromatic as well as spatial. During the hyena sequences, angular rock formations frame the characters diagonally, amplifying menace and instability.

Camera and Depth Staging

Even within 2D constraints, depth is simulated through layered multiple plane compositions. Foreground, mid ground, and background elements guide viewer attention. For example, during Rafiki's presentation of Simba, animals bow in concentric spatial layers, directing the gaze upward toward the cub. Staging in *The Lion King* is therefore not merely compositional it is thematic. It organizes narrative focus, emotional weight, and symbolic meaning.

6.2.4. Straight Ahead versus Pose-to-Pose

The film's fluidity is also shaped by the interplay between Straight Ahead and Pose-to-Pose techniques.

Straight Ahead

In contrast, high-energy sequences such as the wildebeest stampede incorporate Straight Ahead elements. The chaotic motion of dust, debris, and crowd movement requires spontaneity and kinetic unpredictability. This technique prevents mechanical repetition. Similarly, fire sequences in the final battle likely employ Straight Ahead drawing to simulate flickering, irregular combustion patterns. The strategic combination of these techniques produces balanced animation: controlled acting supported by organic dynamism.

Pose-to-Pose

Most character-driven acting scenes rely heavily on Pose-to-Pose construction. Key emotional extremes are clearly defined:

- Mufasa's authority stance
- Scar's languid posture
- Adult Simba's resolved silhouette

The key poses are strategically drawn and in-between frames refine the transitions. This ensures performance precision and dramatic clarity. The confrontation scenes between Scar and Simba illustrate disciplined Pose-to-Pose methodology, allowing animators to maintain weight consistency and character model integrity during emotionally charged exchanges.

Integrated Impact on the movie

The sustained integration of these four principles results in what may be termed classical fluid continuity. Motion in *The Lion King* is never abrupt, visually confusing, or physically implausible. Instead:

- Squash and Stretch provides elasticity.
- Anticipation provides preparation.
- Staging provides clarity.
- Pose-to-Pose and Straight Ahead provide structural coherence.

The principles do not function independently but interdependently. For example, a staged silhouette gains expressiveness through Squash and Stretch, while Anticipation reinforces both structural methods. What distinguishes *The Lion King* is not simply its use of the principles, but their restraint and calibration. The film avoids over-exaggeration while preserving expressiveness. It demonstrates that classical 2D animation can achieve organic realism without digital physics engines by relying on disciplined application of foundational principles.

The film thus reinforces the enduring relevance of the 12 principles, particularly within traditional animation contexts. Far from being obsolete in the digital era, these principles remain structurally indispensable. Through its meticulous integration of Squash and Stretch, Anticipation, Staging, and the interplay between Straight Ahead and Pose-to-Pose techniques, *The Lion King* exemplifies the maturity of classical 2D animation. The principles collectively construct fluid motion, narrative clarity, emotional depth, and visual coherence. Their sustained and calibrated application validates their continued centrality to successful animated filmmaking.

7. Analytical review of four Animation Principles in contemporary 3D Production: Moana

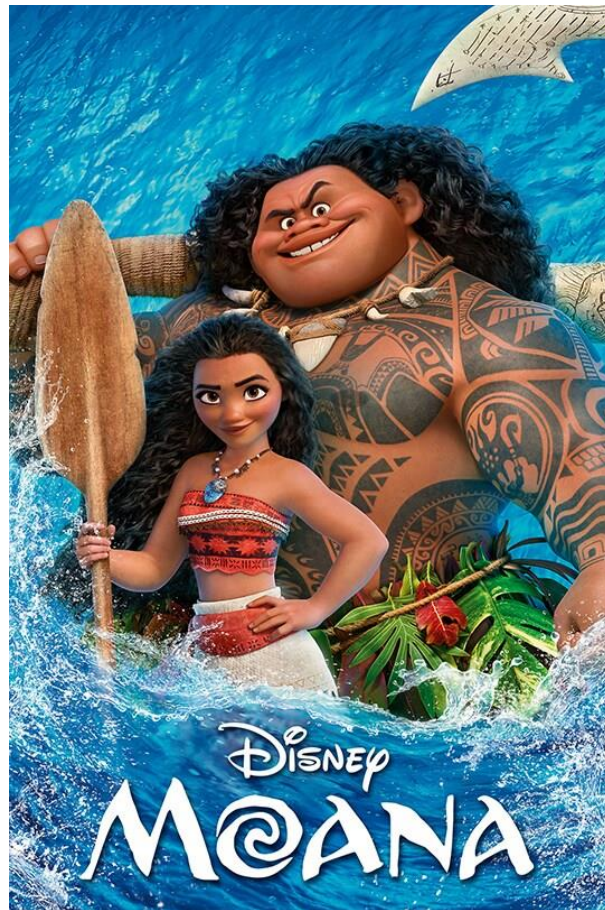


Figure 1.1: Moana (Disney Movies)

Moana (2016), produced by Walt Disney Animation Studios and directed by John Musker and Ron Clements, represents a significant advancement in contemporary 3D character animation, particularly in its integration of physically based simulation with classical animation principles as shown in Figure 1.1 above. Set within a mythological inspired Polynesian context, the film narrates the journey of Moana, a young chief's daughter chosen by the ocean to restore ecological balance by returning the heart of Te Fiti.

While the film is often discussed for its cultural collaboration and musical composition, its animation excellence lies in the sophisticated deployment of foundational principles articulated by Thomas and Johnston (1981). This review evaluates the film through four principles particularly suited to 3D animation analysis: Follow-Through and Overlapping Action, Slow In and Slow Out, Arcs, and Secondary Action. These principles are especially critical in digital animation, where realism is achieved through a balance between simulation and animator-driven exaggeration.

7.1 Follow-Through and Overlapping Action

Follow-through and overlapping action are extensively and masterfully applied throughout Moana, particularly in sequences involving hair, clothing, ocean interaction, and bodily motion.

Hair and Costume Dynamics

One of the most striking demonstrations occurs during Moana's ocean voyages. As she navigates turbulent waters, her long, textured hair exhibits delayed motion relative to her head movements. When she turns abruptly to address Maui, her hair continues traveling briefly before settling demonstrating follow-through. Simultaneously, different strands respond at slightly offset intervals, illustrating overlapping action.

Similarly, Moana's layered garments especially her woven skirt and sash react independently to wind and body motion. When she runs across the beach in the opening sequences, the skirt flutters with staggered timing. The main torso motion initiates first, followed by cloth displacement, reinforcing realism and material believability.

Ocean as Character

The ocean itself is animated with overlapping motion. In scenes where the water interacts playfully with Moana as a child, wave crests retract slightly after the main body of water shifts, demonstrating fluid follow-through. When the ocean withdraws after presenting the heart of Te Fiti, the delayed ripple effect reinforces mass and viscosity.

The ocean's animated responsiveness showcases a complex blend of simulation and animator-controlled timing ensuring it remains expressive rather than purely physical.

Maui's Body Performance

Maui's exaggerated physique provides further examples. When he lands heavily after transformation attempts, his body mass settles with slight residual movement shoulders compress, pectoral muscles subtly lag behind torso motion. This prevents rigidity and enhances perceived weight.

Through these calibrated applications, Moana demonstrates how follow-through and overlapping action are indispensable for believable 3D performance.

7.2 Slow In and Slow Out: Kinetic Naturalism and Emotional Weight

Slow In and Slow Out (ease-in/ease-out) governs acceleration and deceleration, preventing mechanical motion.

Oceanic Movement

The canoe sequences provide compelling examples. When Moana adjusts the sail, the rope does not snap instantly into position. Instead, it begins slowly, accelerates mid-motion, and gradually settles. The sail fabric exhibits progressive acceleration as wind pressure builds, followed by gradual stabilization.

Character Locomotion

Moana's running patterns illustrate this principle. During her training montage and early attempts to sail, her footsteps begin with subtle acceleration. When she halts abruptly in fear such as during her first encounter with Te Kā her body compresses slightly before stopping fully. The deceleration phase communicates mass and inertia.

Emotional Beats

Slow In and Slow Out also functions dramatically. When Moana confronts her grandmother Tala's spirit in manta ray form, her reach toward the ocean is gradual and deliberate. The slow initiation reinforces emotional vulnerability. The extension accelerates slightly before tapering off into stillness, enhancing dramatic gravity. Without this timing modulation, movements would appear robotic. Instead, the film sustains natural motion rhythm consistent with lived experience.

7.3 Arcs: Organic Motion Pathways

Arcs are essential in preventing linear mechanical movement. In Moana, nearly all organic motion follows curved trajectories.

Character Gestures

Moana's arm movements during musical sequences such as "How Far I'll Go" trace curved pathways rather than straight lines. When she reaches outward toward the horizon, her hand follows a gentle arc upward before descending slightly. This arc introduces elegance and emotional lyricism. Maui's gestures are exaggerated yet still arc-based. Even in comedic moments such as when he flexes or dismisses Moana his limbs move along curved trajectories, preserving fluidity despite caricature.

The ocean's wave formations inherently follow arcs. When water envelops Moana's canoe, the crest curves forward and collapses along a natural parabolic pathway. This adherence to arcs sustains both physical realism and aesthetic harmony.

Creature Animation

The lava monster Te Kā exhibits arcs even within destructive movement. When her arms swing downward, the motion follows a curved descent rather than angular impact, reinforcing both scale and organic flow. Arcs in Moana prevent stiffness and enhance aesthetic continuity, aligning movement with natural biomechanical principles.

7.4 Secondary Action: Behavioral Nuance and Performance Complexity

Secondary action enriches primary movement by adding complementary gestures that reinforce personality.

Character secondary Actions

When Moana speaks assertively to Maui, her primary action is dialogue delivery. However, secondary gestures raised eyebrows, subtle shoulder shifts, shifting weight from one foot to another enhance emotional intensity. These small movements reinforce her determination and internal conflict.

During moments of doubt, her fingers subtly tighten against the oar or fabric of her garment. These secondary details deepen character psychology.

One of the film's most innovative uses of secondary action appears in Maui's animated tattoos. These tattoos respond independently, commenting on his behavior. For example, when he hesitates or lies, the miniature tattoo version of himself reacts critically. This secondary animation supports narrative humor and character introspection without disrupting the main action.

Environmental Secondary Action

In high-wind sequences, foliage in the background sways subtly as characters interact in the foreground. These layered movements prevent static environments and reinforce immersion.

Secondary action in Moana enhances dimensional richness and performance authenticity.

Integrated Impact on the movie

What distinguishes Moana is not merely its reliance on simulation technology but its disciplined adherence to classical animation principles within a 3D pipeline. The film integrates:

- Physically based cloth and water simulation
- Animator-controlled performance exaggeration
- Timing modulation
- Curvilinear motion design

- Multi-layered gesture reinforcement

The principles of Follow-Through, Slow In/Out, Arcs, and Secondary Action are not abandoned in favor of realism; rather, they are embedded within digital tools to elevate realism.

From the researcher’s analytical perspective, Moana exemplifies the mature adaptation of classical animation principles within a contemporary 3D production environment. Follow-through and overlapping action generate material believability; Slow In and Slow Out produce kinetic authenticity; Arcs sustain organic fluidity; and Secondary Action enriches psychological depth.

The film demonstrates that even within advanced Computer Generated Image (CGI) systems, the foundational principles articulated in traditional animation remain structurally indispensable. Rather than being replaced by technology, these principles continue to guide motion credibility, emotional clarity, and narrative immersion in modern animated cinema.

8. Analytical review of four Animation Principles: The Chicken Run



Figure 1.2: Chicken Run (<https://www.imdb.com/title/tt0120630/>)

Chicken Run (2000), directed by Peter Lord and Nick Park and produced by Aardman Animations in partnership with DreamWorks Animation, represents a landmark achievement in feature-length stop-motion cinema as shown in Figure 1.2 above. As Aardman’s first full-length feature, the film combines handcrafted clay animation with precise performance timing and comedic exaggeration to produce a visually distinctive and commercially successful narrative.

Unlike hand-drawn or CGI animation, stop-motion relies on physically manipulated puppets photographed frame-by-frame. This production method inherently introduces resistance gravity, material stiffness, and tactile limitations which must be overcome through disciplined application of animation principles. This review evaluates Chicken Run

through four foundational principles: Timing, Exaggeration, Solid Drawing and Appeal, demonstrating how stop-motion adapts classical animation theory to a materially constrained medium.

8.1 Timing: Comedic Rhythm and Physical Weight

Timing in stop-motion animation is particularly demanding because each movement must be manually adjusted and captured frame-by-frame. In *Chicken Run*, timing functions as the primary driver of humor, tension, and character personality.

Comedic Timing

The film's comedic structure relies heavily on delayed reactions and rhythmic pacing. For example, in early scenes when Ginger's escape attempts repeatedly fail, there is often a pause between her realization and the Tweedys' intervention. This slight delay enhances comic inevitability. Mr. Tweedy's suspicion that "the chickens are organized" is followed by a micro-beat of silence before Mrs. Tweedy dismisses him. The timing of this exchange heightens humor by extending anticipation just long enough for audience expectation to build.

Physical Timing and Weight

Stop-motion puppets possess inherent physical mass. The animators exploit this through careful frame spacing. When Rocky crash-lands into the chicken yard, his descent accelerates and then compresses upon impact, followed by a subtle rebound. The number of frames allocated to impact and recovery communicates weight convincingly. Similarly, when Mrs. Tweedy falls into the pie machine during the climax, her descent is not instantaneous. The controlled acceleration followed by a delayed, heavy landing reinforces gravity and scale.

Emotional Timing

During moments of despair such as when Ginger discovers Rocky has fled the pacing slows noticeably. Movements become restrained and fewer frames separate poses, allowing emotional gravity to settle. This temporal modulation deepens narrative engagement. Thus, timing in *Chicken Run* is not merely mechanical it structures comedic rhythm, conveys physical realism, and shapes emotional cadence.

8.2. Exaggeration: Caricature and Expressive Amplification

Exaggeration is fundamental to Aardman's animation style. In *Chicken Run*, exaggeration operates at both visual and behavioral levels.

Facial Exaggeration

The clay characters are designed with simplified facial geometry, allowing for bold distortions. When Mrs. Tweedy becomes enraged, her eyes narrow dramatically and her jaw juts forward in sharp angular extension. This exaggeration enhances her villainous presence without departing from the established aesthetic. Mr. Tweedy's perpetually bewildered expressions are achieved through exaggerated brow arches and slackened jaw shapes. His reaction shots often extend beyond naturalistic realism, amplifying comedic effect.

Physical Exaggeration

The chickens' attempts at physical feats particularly early "flying lessons" with Rocky demonstrate deliberate exaggeration. Their flapping motions are amplified beyond realistic poultry biomechanics, with wings sweeping in wide arcs and bodies bouncing vertically in exaggerated anticipation. The pie machine explosion scene culminates in a mushroom cloud of gravy an overtly exaggerated visual gag that reinforces the film's comedic tone. Importantly, exaggeration is calibrated. It intensifies emotion and humor without collapsing into visual chaos. The exaggeration remains coherent within the film's stylized world.

8.3. Solid Drawing: Volumetric Integrity in Three-Dimensional Puppetry

Although Solid Drawing traditionally refers to convincing three-dimensional form in 2D animation, its equivalent in stop-motion lies in volumetric consistency, weight distribution, and structural integrity.

Puppet Construction and Dimensionality

The characters in *Chicken Run* possess rounded, tangible forms that respond convincingly to lighting. Their clay bodies cast real shadows, reinforcing spatial authenticity. Unlike drawn characters, these puppets occupy literal three-dimensional space. The lighting in interior barn scenes accentuates surface curvature and texture. The physical presence of clay enhances material believability.

Balance and Weight

When the chickens assemble the aircraft in the final act, the strain of lifting parts is conveyed through bodily compression and posture shifts. The animators adjust the puppets incrementally to simulate muscular exertion. Fowler's stiff, upright posture contrasts with Ginger's forward-leaning determination, visually reinforcing personality through structural stance.

Spatial Depth

The farm environment is constructed in layered miniature sets. Foreground fencing, mid ground coops, and background sky establish convincing depth. The cinematography respects dimensional continuity, preventing spatial flattening. Thus, Solid Drawing in *Chicken Run* is achieved not through illusion but through tangible construction making it perhaps the most literal embodiment of the principle among animation forms.

8.4. Appeal: Character Design and Emotional Accessibility

Appeal ensures that characters attract audience engagement, whether heroic, comedic, or antagonistic.

Character Design Variety

The chickens are visually distinct despite similar species anatomy. Ginger's larger comb and confident stance signal leadership. Babs' rounded eyes and softer posture convey innocence. Fowler's angular features suggest rigidity and tradition.

This variation in shapes adheres to the principle of silhouette clarity and proportional diversity.

Villainous Appeal

Mrs. Tweedy's angular features and rigid posture create visual tension. Her exaggerated narrow eyes and sharp cheek structure contrast strongly with the rounded chickens, reinforcing moral polarity.

Emotional Relatability

Despite being clay figures, the chickens' performances are emotionally legible. Ginger's determination, Rocky's bravado, and Mr. Tweedy's confusion are communicated through readable facial shifts and body language. The handcrafted imperfections slight texture irregularities and tactile surfaces enhance rather than diminish appeal. The material authenticity invites viewer empathy.

Integrated Evaluation

What distinguishes *Chicken Run* is how these principles compensate for the inherent constraints of stop-motion. The medium imposes physical limits: gravity, puppet stiffness, and incremental manipulation. Through disciplined timing, calibrated exaggeration, volumetric solidity, and carefully constructed appeal, the animators overcome these constraints to produce fluid and expressive performance.

- Timing provides rhythm.
- Exaggeration provides humor.
- Solid construction provides realism.
- Appeal provides audience connection.

Unlike CGI, where physics engines simulate realism, stop-motion demands physical craftsmanship to embody these principles. *Chicken Run* demonstrates that classical animation principles remain indispensable across mediums, even when the production pipeline is materially different.

From a researcher's analytical perspective, *Chicken Run* exemplifies the adaptive resilience of classical animation principles within stop-motion production. Through precise timing, expressive exaggeration, tangible solid form, and compelling appeal, the film achieves both comedic vitality and structural coherence.

Its success affirms that the foundational principles articulated by Thomas and Johnston are not medium-dependent but medium-transcendent. In stop-motion, these principles are not merely theoretical they are physically enacted frame by frame.

9. Conclusion

The comparative analyses of *The Lion King* (2D), *Moana* (3D CGI), and *Chicken Run* (Stop Motion) collectively demonstrate a decisive truth: the twelve animation principles remain the structural foundation of convincing animated motion, irrespective of medium or technological advancement.

Although originally articulated within the context of classical hand-drawn animation, these principles function not as stylistic conventions but as motion laws governing believability, clarity, rhythm, and emotional resonance. Across all three animation forms examined, the consistent and calibrated implementation of Squash and Stretch, Anticipation, Staging, Straight Ahead and Pose-to-Pose action, Follow-Through and Overlapping Action, Slow In and Slow Out, Arcs, Secondary Action, Timing, Exaggeration, Solid Drawing, and Appeal proved central to the success of performance and storytelling.

In 2D animation, these principles compensate for the absence of physical reality by manually simulating elasticity, weight, and dimensional form. In 3D CGI, they guide key frame construction and refine physically based simulations, ensuring that digital motion does not devolve into mechanical interpolation. In stop motion, they overcome material rigidity through disciplined frame-by-frame manipulation, preserving fluidity within tangible constraints. In each case, technology facilitates execution, but principles determine credibility.

Critically, software does not generate anticipation; physics engines do not create appeal; rendering algorithms do not establish timing or exaggeration. These remain animator-driven decisions rooted in principle-based thinking. When properly applied, the principles transform motion into performance and movement into narrative. When neglected, animation regardless of rendering sophistication becomes stiff, confusing, or emotionally inert.

The findings therefore affirm that the "Golden Rules of Animation" are not optional aesthetic devices but indispensable structural mechanisms. They function as the grammar of animated motion organizing spatial clarity, temporal rhythm, emotional expression, and volumetric integrity. Their relevance is medium-transcendent and historically resilient.

As animation technologies continue to evolve from hand-drawn to CGI to hybrid pipelines the foundational principles persist as the constant variable underlying classical motion and effective storytelling. Mastery of tools may enhance production efficiency; mastery of principles determines artistic success.

In conclusion, irrespective of animation type, the sustained and deliberate implementation of the twelve animation principles remains mandatory for achieving fluidity, believability, and compelling narrative impact.

9.1 Limitations of the Study

Although the study provides valuable insights into the continued relevance of the Twelve Principles of Animation across 2D, 3D CGI, and stop-motion animation, several limitations should be acknowledged.

First, the study relied exclusively on qualitative visual observation and interpretive analysis of selected animated films. While this approach allowed for an in-depth examination of animation principles as they appear in actual production contexts, the findings are inherently interpretive and may be influenced by the researchers' analytical

perspective. Although repeated viewing and systematic observation were employed to enhance consistency, alternative researchers may identify additional nuances or arrive at different interpretations. This limitation is characteristic of qualitative visual studies.

Second, the research examined only three feature films which are *The Lion King* (1994), *Moana* (2016), and *Chicken Run* (2000) selected to represent 2D animation, 3D Computer-Generated Animation, and Stop-Motion animation respectively. While these films are widely recognized as exemplary works within their respective animation traditions, they cannot fully represent the diversity of animated productions across different countries, studios, genres, and historical periods. Consequently, the findings should be interpreted within the context of the selected case studies rather than generalized to all animated films.

Third, to maintain analytical depth and manageability, the study organized the Twelve Principles of Animation into thematic clusters and analyzed only four principles in relation to each selected film. Although all twelve principles were discussed conceptually, not every principle received equal analytical attention within each case study. A more comprehensive examination of all twelve principles across each film might reveal additional insights regarding their interaction and application.

Finally, animation technologies continue to evolve rapidly through developments in real-time rendering, artificial intelligence, virtual production, and procedural animation systems. As a result, some production practices discussed in this study may continue to transform, requiring ongoing scholarly examination of how traditional animation principles adapt to emerging technological environments.

Despite these limitations, the study successfully demonstrates the enduring relevance of the Twelve Principles of Animation and provides a useful framework for understanding their application across multiple animation mediums.

9.2 Suggestions for Future Research

The findings of this study present several opportunities for further scholarly investigation.

First, future research could expand the scope of analysis by examining a larger sample of animated films across different cultures, studios, and production periods. Comparative studies involving Asian, African, European, and Latin American animation traditions may provide deeper insights into whether the application of animation principles varies according to cultural and artistic contexts.

Second, future studies may investigate all twelve principles simultaneously within individual animated productions. Such research could provide a more holistic understanding of how the principles interact collectively to support character performance, visual storytelling, and audience engagement.

Third, researchers may explore the application of animation principles within emerging forms of animation production, including virtual reality (VR), augmented reality (AR), real-time animation, virtual production environments, and artificial intelligence-assisted animation systems. As technological innovations continue to reshape animation workflows, it is important to understand whether traditional principles retain their relevance or require adaptation.

Fourth, future studies could adopt mixed-method or audience-based research approaches to examine how viewers perceive and respond to the implementation of animation principles. Surveys, focus groups, and experimental studies could complement qualitative observations by providing empirical evidence regarding audience engagement, emotional response, and narrative comprehension.

Additionally, researchers may investigate the pedagogical value of the Twelve Principles of Animation within animation education. Studies focusing on animation students, professional animators, and training institutions

could evaluate how effectively these principles are taught and how they contribute to skill development in contemporary animation curricula.

Finally, future research may explore the relationship between animation principles and specific production components such as character design, cinematography, lighting, visual effects, motion capture, facial performance, and storytelling structure. Such investigations would contribute to a more comprehensive understanding of how animation principles function within increasingly complex production pipelines.

Through these avenues, future scholarship can continue to build upon the findings of this study and further establish the enduring significance of the Twelve Principles of Animation within both traditional and emerging forms of animated media.

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