Multimedia Animation

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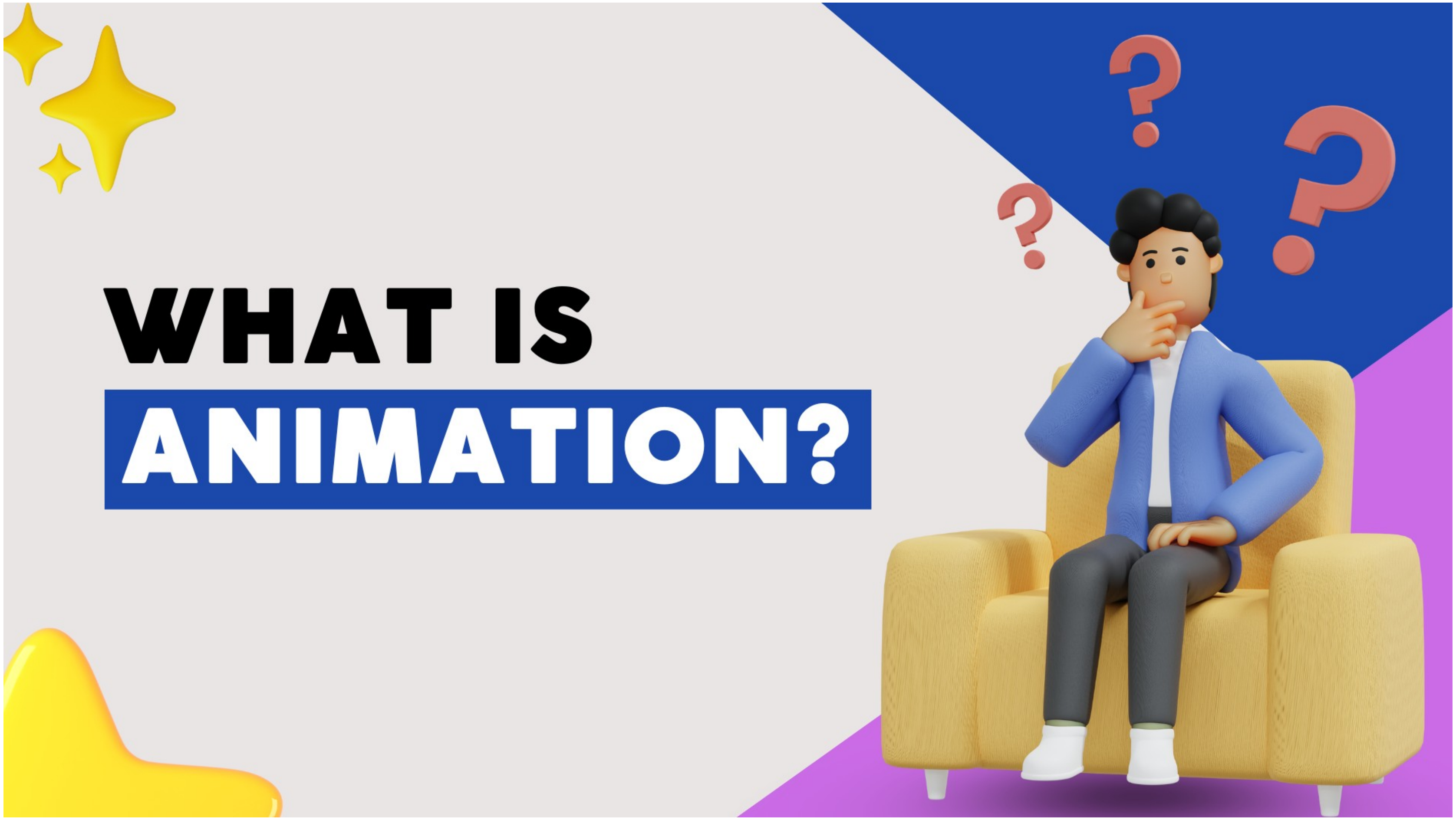

WHAT IS
ANIMATION?

Animation

- Animation is the process of creating the illusion of movement by displaying a series of still images or frames in rapid succession.
- Each image differs slightly from the one before it, and when played quickly, the brain perceives them as continuous motion—kind of like a flipbook brought to life.

Animation

- Animation is a method of photographing successive drawings, models, or even puppets, to create an illusion of movement in a sequence.
- Because our eyes can only retain an image for approximately 1/10 of a second, when multiple images appear in fast succession, the brain blends them into a single moving image.

Animation

- In traditional animation, pictures are drawn or painted on transparent celluloid sheets to be photographed.
- Early cartoons are examples of this, but today, most animated movies are made with computer-generated imagery or CGI.

Animation

- To create the appearance of smooth motion from these drawn, painted, or computer-generated images, frame rate, or the number of consecutive images that are displayed each second, is considered.
- Moving characters are usually shot “on twos” which just means one image is shown for two frames, totaling in at 12 drawings per second. 12 frames per second allows for motion but may look choppy.
- In the film, a frame rate of 24 frames per second is often used for smooth motion.

Animation : Types

- Traditional Animation (2D, hand-drawn): Artists draw each frame by hand.
- Digital 2D Animation: Like traditional, but done using software.
- 3D Animation: Uses computer-generated models and environments—think Pixar movies.
- Stop Motion: Real objects are physically moved in small increments and photographed one frame at a time.
- Motion Graphics: Often used in UI/UX, advertising, and explainer videos—less character-focused, more on shapes/text.

Traditional Animation

- Each frame is drawn by hand on paper or a digital tablet. For example, to animate a character waving, the animator draws each position of the hand's movement frame by frame.
- Process:
  - Start with a storyboard and character design.
  - Draw keyframes (main poses).
  - Add in-between frames (called "inbetweens") to create fluid motion.
  - Scan or digitize the drawings and paint them.
  - Compile and play the sequence at 12 or 24 frames per second.

Traditional Animation

- Famous Examples:
  - Disney’s The Lion King (1994)
  - Snow White and the Seven Dwarfs (1937)
  - Studio Ghibli films like Spirited Away

2D Animation

- Similar to traditional, but done using digital tools like Adobe Animate, Toon Boom Harmony, or OpenToonz. Artists still draw keyframes, but software assists with interpolation and coloring.
- Common Techniques:
  - Frame-by-frame animation: Like traditional, just digital.
  - Rigging/Puppet animation: Characters have a digital "skeleton" that can be moved without redrawing each frame.
- Used In:
  - Web cartoons
  - TV shows like Rick and Morty or Adventure Time
  - Educational videos and explainer animations

3D (Computer-Generated Imagery - CGI)

- Artists build 3D models of characters/environments. These models are rigged (given a bone structure) and animated using keyframes and motion paths in software like Blender, Maya, or Cinema 4D.
- Steps:
  - Modeling – building the characters/environments.
  - Rigging – adding bones and joints.
  - Animation – setting movements and timing.
  - Lighting and rendering – adding realistic visuals.
  - Compositing – combining all visual elements.
- Famous Examples:
  - Toy Story (first full-length 3D animated movie)
  - Frozen, Shrek, Avatar

Stop Motion Animation

- Real-life objects (clay models, puppets, paper cutouts, or even LEGOs) are moved in tiny increments, and each position is photographed. When played in sequence, they create movement.
- Types of Stop Motion:
  - Claymation: Using clay models (e.g., Wallace & Gromit)
  - Puppet animation: Using wireframe puppets (e.g., Coraline)
  - Cut-out animation: Using flat characters/paper (e.g., early South Park)

Motion Graphics

- Focuses on animating text, logos, shapes, and graphics rather than characters. Often used in branding, user interfaces, trailers, and corporate videos.
- Created with tools like Adobe After Effects or Apple Motion.
- Common Uses:
  - App and website animations
  - Infographics and explainer videos
  - Title sequences in movies or YouTube

Experimental & Hybrid Animations

- Some creators blend different styles, like mixing 2D with 3D, live-action with animation, or using AI to enhance traditional methods.
- Experimental animation pushes the boundaries of visual storytelling.

Principles of Animation

- The 12 principles of animation are a set of animating guidelines developed by Disney animators in the 20th century.
- These principles were codified by Disney alums Ollie Johnston and Frank Thomas in their 1981 book The Illusion of Life: Disney Animation.
- Because Disney's animation style was so influential —and traditional animation became the dominant approach of the 20th century—animators everywhere use these principles in their work.

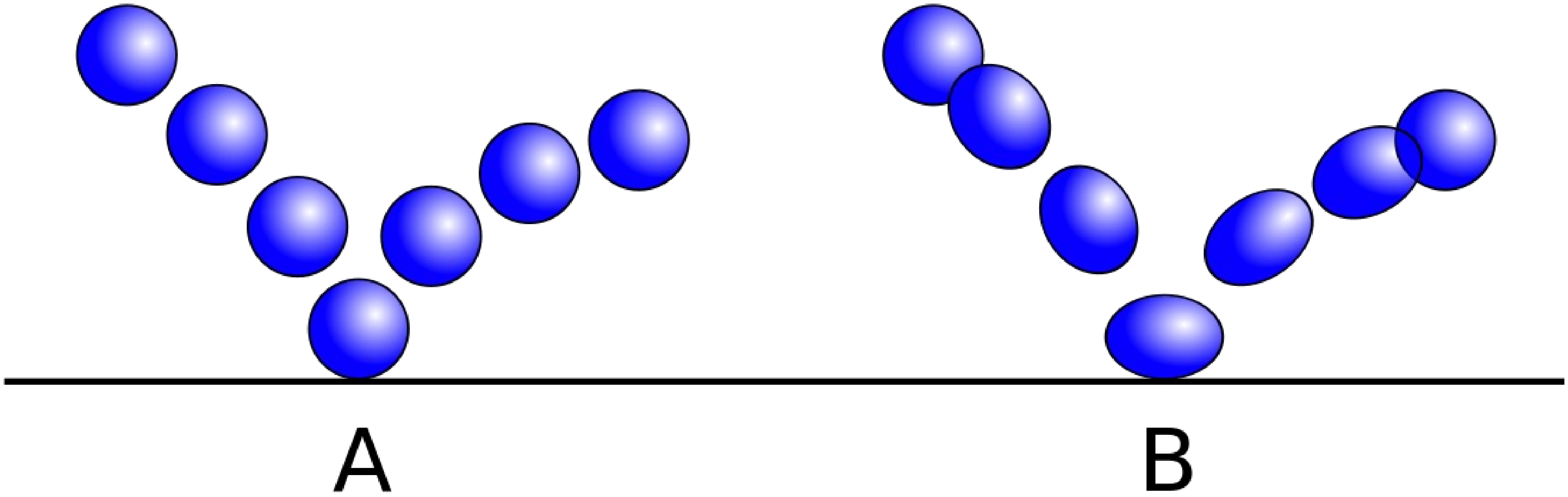
Principles of Animation

- Squash and stretch
- Anticipation
- Staging
- Straight ahead and pose-to-pose
- Follow through and overlapping action
- Slow in and slow out
- Arc
- Secondary action
- Timing
- Exaggeration
- Solid drawing
- Appeal

Squash and Stretch

- Squash and stretch is intended to give weight and malleability to objects.
  - Think about it: if your animated object remains a constant, rigid shape throughout its movement, it’ll look unnatural.
- Squash refers to when an object stops or hits something — it compresses slightly. Stretch, on the other hand, is when an object is speeding up.

Squash and Stretch



Squash and Stretch

- There are a couple rules for squash and stretch. The object should never change volume.
- In other words, if it gets wider, it should also get shorter.
- If it gets taller, it should also get thinner. Second, the more you squash and stretch, the softer the object will appear, and vice versa.

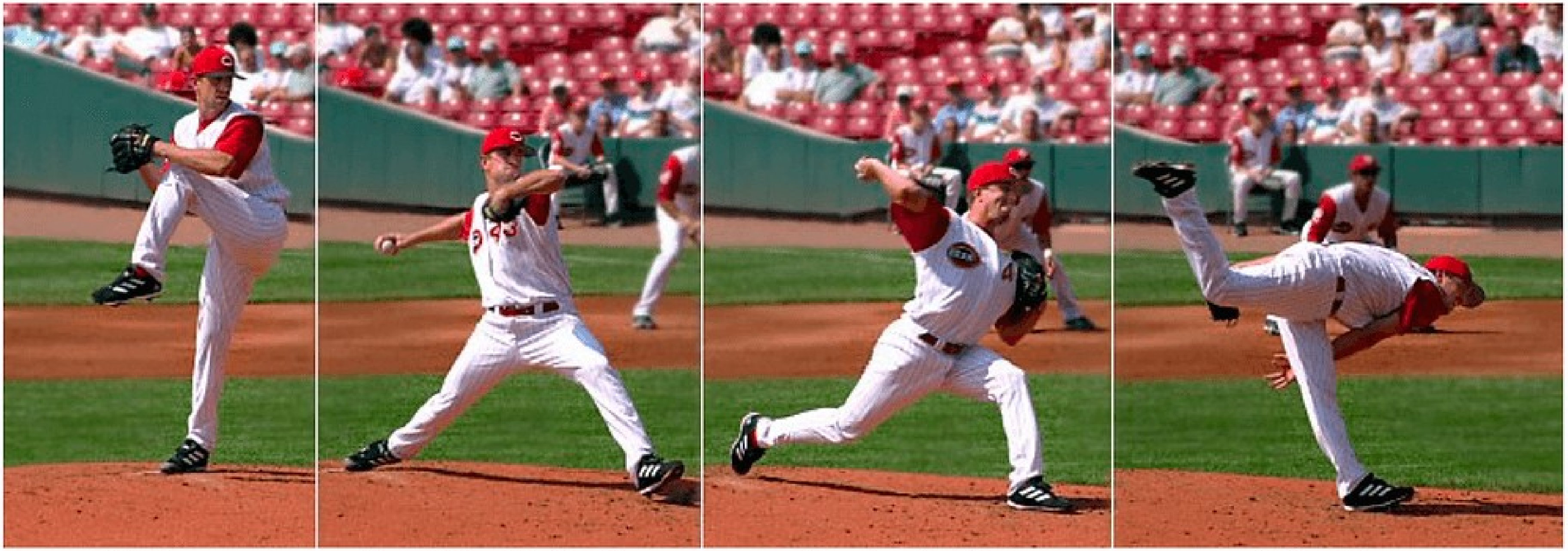
Anticipation

- What it is:
  - A small movement before the main action. Think of a baseball pitcher winding up before throwing.
- Why it matters:
  - Prepares the audience for what's coming and adds realism.

Anticipation

- How do you throw a football? Do you simply raise your arm and jerk it forward?
- If you answered yes to that question, you are likely not throwing your football very far.
- A throw requires a wind up – you bring your arm back so that you can get propulsion behind your movement.

Anticipation



Wind-up *Closed Shoulder Position* *Arm Acceleration* *Follow Through*

Anticipation

- This is the central idea behind anticipation: it’s the preparation before the action. And we’re not just talking about throwing balls.
- If you really pay attention to how things move (and Disney animators did), you’ll notice that almost all movement has an anticipation, even if it’s nearly microscopic.

Staging

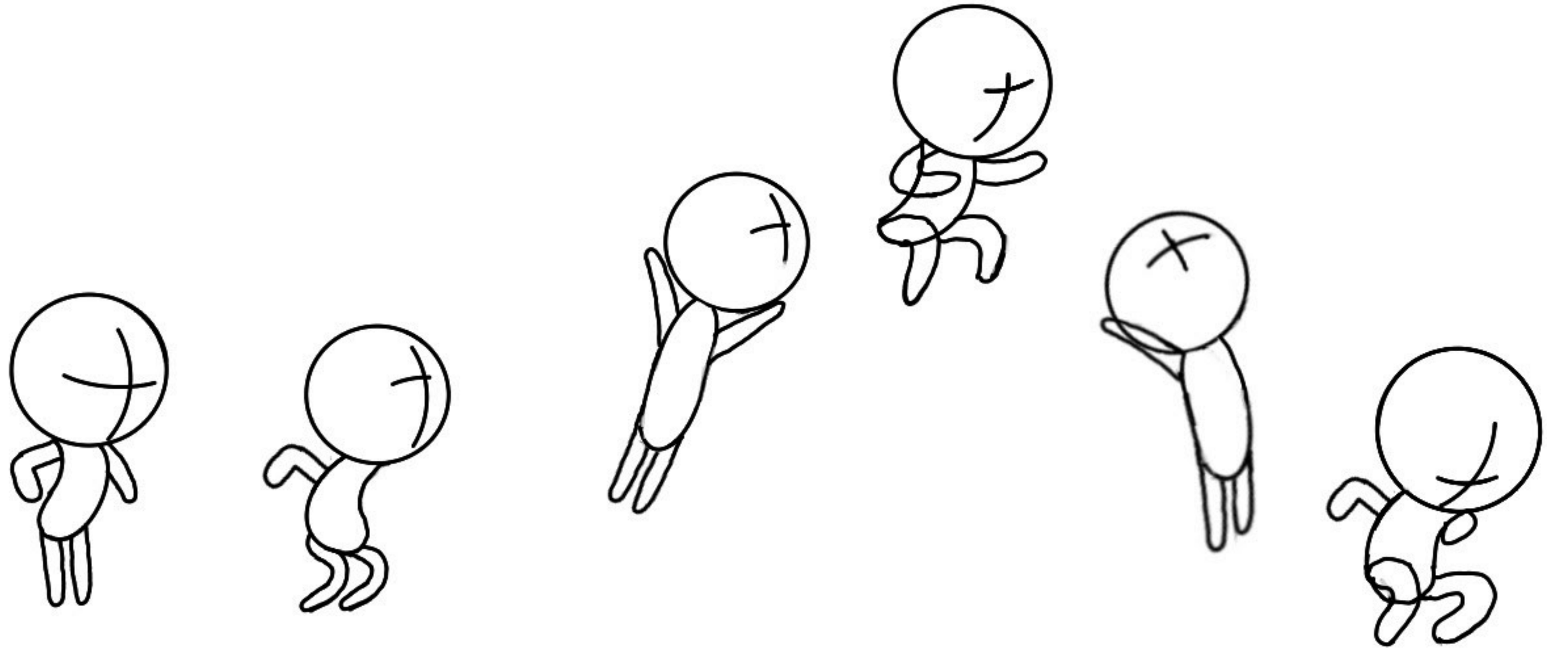
- Staging is a concept Johnston and Thomas borrowed from live-action filmmaking (which borrowed the concept from theater). Staging refers to how you direct the audience's attention in a frame.
- As Johnston and Thomas describe it, it's essentially synonymous with mise-en-scène. Where are objects placed in the frame? What are lighting, color, and setting considerations? Where is the camera placed?
- All of these decisions will help guide the viewer's eye. Notice how our eye goes to the two dancing lovers in this still from Sleeping Beauty:

Staging

Straight ahead action and pose to pose

- This principle refers to how an animator actually animates. With straight ahead action, an animator is going frame by frame sequentially.
- With pose-to-pose, the animator will draw out the key poses that need to be hit, and then draw the in-between frames (also known as tweening).
- Straight ahead is better for fluid, unpredictable movement. This might be fire, water, smoke, etc. The variation from frame to frame will take an animator to unexpected places.
- Pose to pose is a bit more common because it lets an animator plan out how they want a movement to look. In other words, they have more control.

Straight ahead action and pose to pose



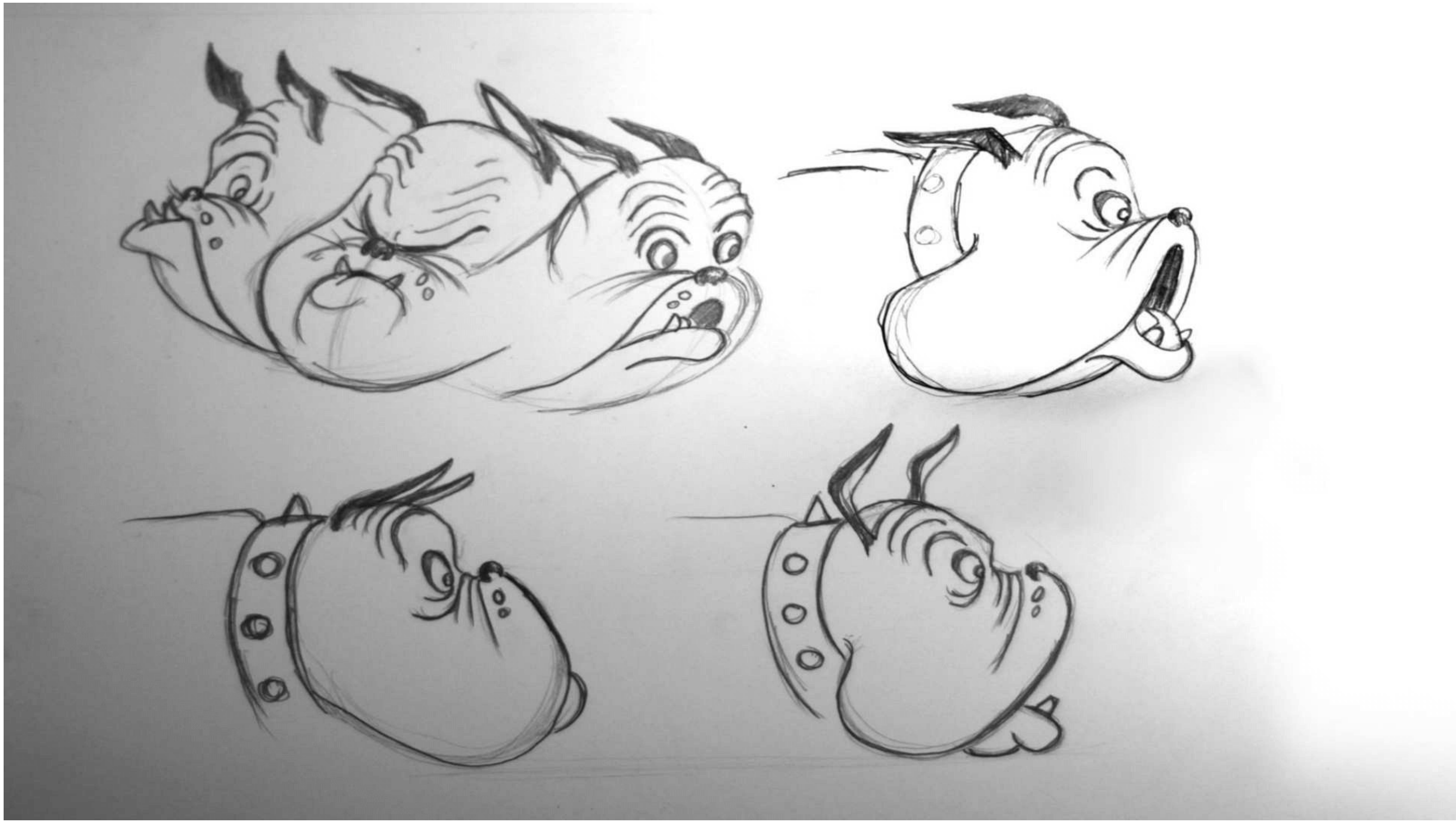
Follow through and overlapping action

- What it is:
  - Follow Through: Parts of the body keep moving after the character stops.
  - Overlapping Action: Different parts of the body move at different rates.
- Why it matters:
  - Adds realism. Makes motion feel more dynamic and less robotic.

Follow through and overlapping action

- Disney animators spent a lot of time studying how things move in the real world. Walt Disney himself would set up physics classes for his animators so that they could more fully understand the science of movement.
- He even brought a deer onto the studio lot when the animators were working on Bambi, as this behind the scenes doc describes:
  - One of the main lessons the animators learned was that of inertia. When something starts moving, it doesn’t stop on a dime – its different elements will slow at different rates.

Follow through and overlapping action



Slow in and slow out

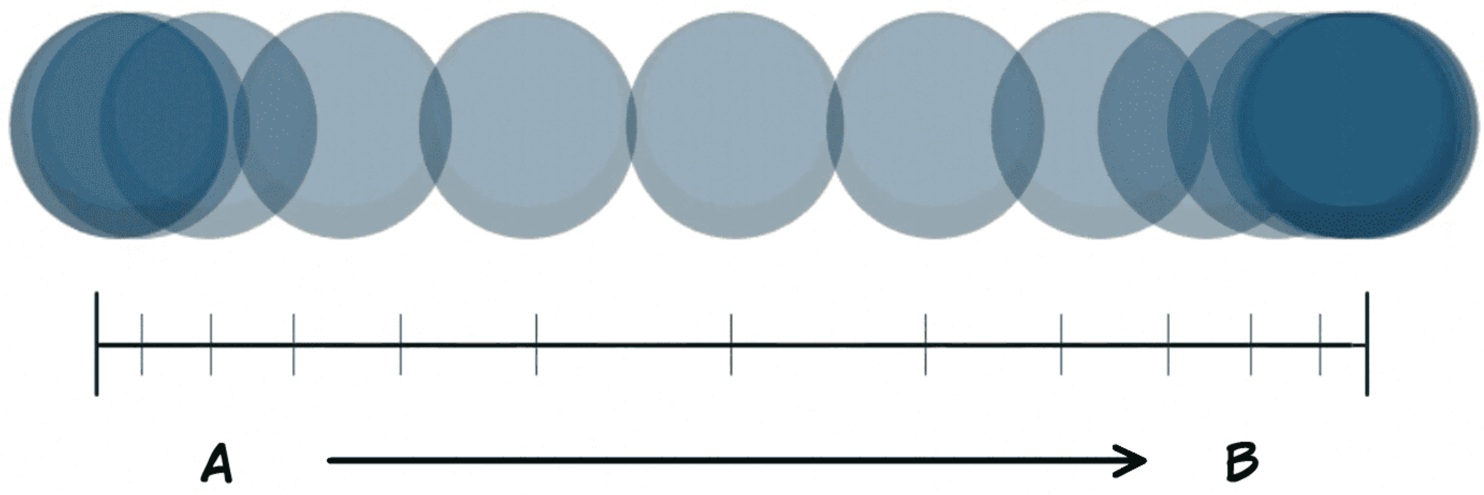
- Slow in and slow out is directly linked to our previous principle. A character doesn’t just start moving at a consistent speed, and they don’t stop on a dime.
- Rather, objects need time to speed up and slow down. Thus: slow in and slow out.
- Practically, this means there need to be more frames at the beginning and end of a movement than in the middle.

Slow in and slow out

SLOW IN AND SLOW OUT

IN-BETWEENS NEAR THE FIRST KEY POSE AND THE LAST ONE

SOFT, SMOOTHED AND REALISTIC MOVEMENT



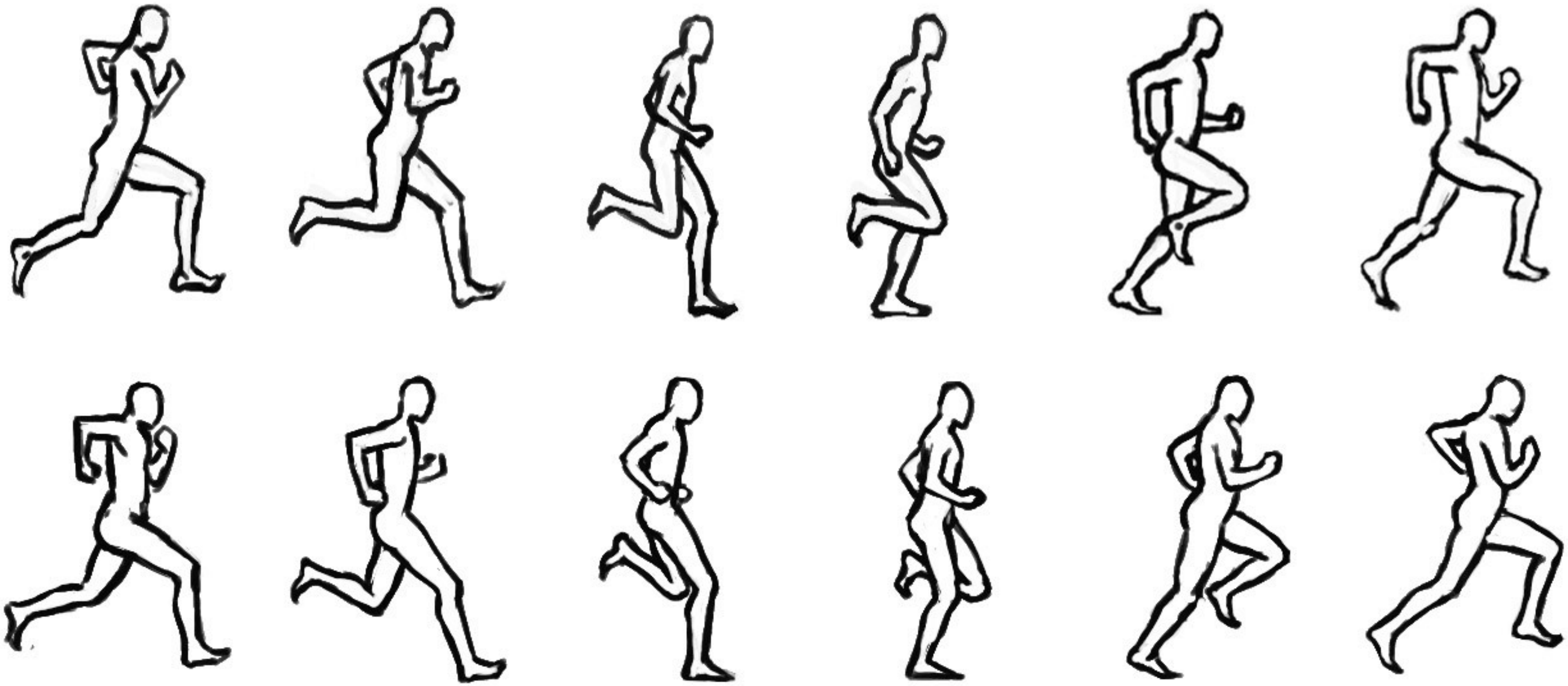
Arc

- Perfectly straight lines are very rare in nature. When Disney animators studied movement, they realized that things didn’t move linearly from point A to point B. Instead, they discovered, movement typically happens in arcs.
- This lesson can be applied to movements big and small.
- Note the movement of Basil’s head in this scene from The Great Mouse Detective – it’s all small arcs.

Secondary action

- Say you want to draw a character running. What would need to be animated? The first thing that probably comes to mind are probably the legs.
- But no one runs with only their legs. They pump their arms. Their head bobs. They breathe heavily.

Secondary action



Secondary action

- All of these movements are referred to by Johnston and Thomas as secondary action. Secondary action supplements the primary movement without distracting from it.
- If a character is admiring a skyscraper, for instance, the primary action would be their eyes looking up.
- A secondary action may be the drools sliding out of their gaping mouth.

Timing

- What it is:
  - The number of frames used to depict an action. Fewer frames = faster action, more frames = slower action.
- Why it matters:
  - Sets the mood, emotion, and realism. Good timing = good storytelling.

Timing

- The principle of timing refers more directly to the mechanics of animation.
  - The core of the principle: the number of frames a movement is given dictates how much time a movement will take.
- With timing, physics should be taken into account, of course, but so should emotion. Go back to our skyscraper admirer.
- We'd probably want that movement to be slow to highlight the awe the character feels.

Timing

- The number of frames is only one of the considerations within timing.
- An animator must also decide on how long to hold on each frame.
- Animating on 1's refers to animating a new image on each frame.
- Animating on 2's (arguably the most popular approach for traditional animation) is when each drawing lingers for two frames.
- Animating on 3's can be found in much of anime, and is when an animator draws a new image for every three frames.

Exaggeration

- What it is:
  - Enhancing actions or features for greater impact—like stretching a facial expression or exaggerating a jump.
- Why it matters:
  - Adds drama, humor, or clarity. Makes animation feel alive.

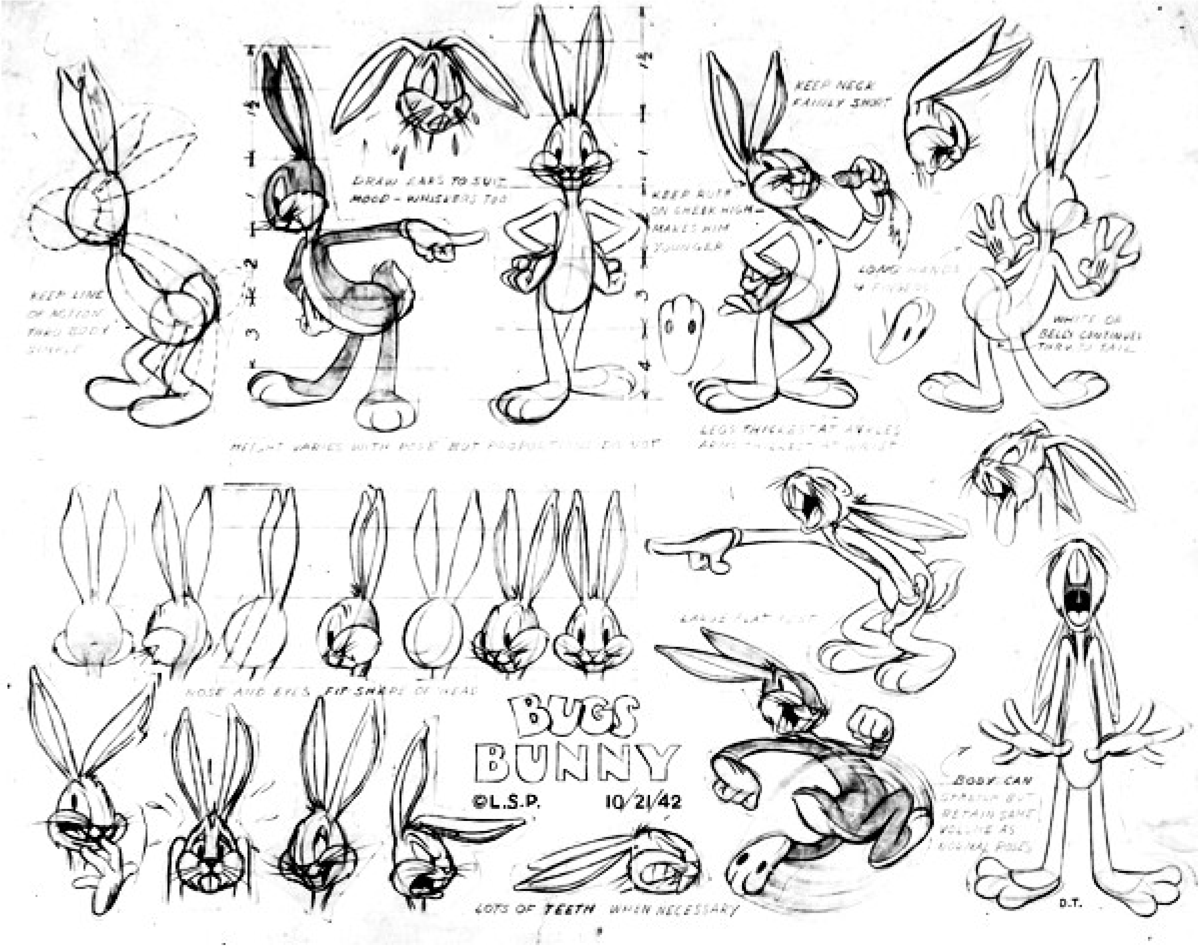
Exaggeration

- So far, we’ve focused a lot on imitating reality. But why animate if you’re trying to perfectly mimic reality? The beauty of the medium is that you can heighten reality. This is where exaggeration comes in.
- A character is shocked? Put their jaw on the floor. A character is crying? Have waterfalls spouting out of their eyes. Is your character attracted to someone? Well, you can do this:
- A quick tip for exaggeration: the quicker a movement is, the more exaggerated you can get, since it will take more to register with the audience.

Solid drawing

- This is one of the principles which is slightly less relevant with today's 3D animation.
- The idea with solid drawing is that even though you're drawing 2D characters, you need to take into account 3D space.
- For Johnston and Thomas, this meant animators should study classical solid drawing before getting into the business. They argued that this background was crucial for a dynamic animator.

Solid drawing


KEEP LINE OF ACTION THRU BODY SIMPLE
DRAW EARS TO SUIT MOOD – WHISKERS TOO
HEIGHT VARIES WITH POSE BUT PROPORTIONS DO NOT
KEEP RUFF ON CHEEK HIGH – MAKES HIM YOUNGER
KEEP NECK FAIRLY SHORT
LONG HANDS 4 FINGERS
WHITE OF BELLY CONTINUES THRU TO TAIL
LEGS THICKEST AT ANKLES ARMS THICKEST AT WRIST
NOSE AND EYES FIT SHAPE OF HEAD
LARGE FLAT FEET
BUGS BUNNY
©L.S.P.
10/21/42
LOTS OF TEETH WHEN NECESSARY
BODY CAN STRETCH BUT RETAIN SAME VOLUME AS NORMAL POSES
D.T.

Solid drawing

- Within their solid drawing principle, the duo also discourage “twins,” referring to characters that have identical left and right sides.
- Movement shouldn’t mirror, and neither should a character's looks. Again, this is all in reference to the real world – perfectly symmetrical movement doesn’t feel organic.

Appeal

- Appeal refers to the charisma of a character and their design. There’s no one way to do this, but in essence, a character should feel real and visually interesting.
- This often requires a ton of trial and error. Take, for example, Hayao Miyazaki’s Totoro.
- Johnston and Thomas recommend giving likable characters round and childlike faces, but even this can be subverted. What’s important is that a character draws an audience’s eye.
- Use exaggeration, play with shapes and proportions, anything to create something original and captivating.

Summary

Principle	Purpose
Squash and Stretch	Adds weight/flexibility
Anticipation	Prepares for action
Staging	Clarity and focus
Straight Ahead & Pose-to-Pose	Fluidity vs. structure
Follow Through & Overlapping	Realistic movement
Slow In & Slow Out	Smooth starts and stops
Arcs	Natural motion
Secondary Action	Adds richness
Timing	Controls emotion and realism
Exaggeration	Emphasizes movement/emotion
Solid Drawing	Realistic, believable characters
Appeal	Keeps characters interesting and relatable

Animation Sequence

- An animation sequence is a series of shots or scenes arranged in a specific order to show progression in time, action, or story.
- It can be as short as a few seconds (like a character jumping) or as long as a full movie scene.

1. Concept and Storyboarding

- What happens:
  - Define what the scene is about (story, message, or action).
  - Create storyboards – rough sketches of each major shot or moment.
  - Define camera angles, composition, and character positions.
- Tools:
  - Paper, Photoshop, Storyboard Pro, or even PowerPoint for quick boards.
- Example:
  - Character sees a balloon, runs to catch it, jumps, and misses. Each of those key moments is a frame in the storyboard.

2. Script and Dialogue (if any)

- If your sequence has narration, speech, or dialogue, write or include that script.
- Syncing voice and motion later becomes easier.

3. Animatic Creation

- What happens:
  - Combine storyboard frames with timing and sound to make an animatic.
  - This is the animated version of the storyboard.
  - Helps test pacing, shot timing, and scene flow.
- Tools:
  - Adobe Premiere Pro, After Effects, Blender (for roughs), or even free apps like OpenToonz.

4. Layout and Background Design

- What happens:
  - Design the backgrounds, environments, and staging.
  - Define where the action takes place.
- Includes:
  - Perspective setup
  - Color palette
  - Lighting mood

5. Character Design & Rigging (if needed)

- Before animation starts, characters must be:
  - Finalized in design
  - Possibly rigged (in 2D puppet or 3D skeletal form)

6. Keyframing / Blocking the Sequence

- What happens:
  - Animate key poses first (major movements).
  - This is called blocking in 3D animation or keyframe animation in 2D.
- Example:
  - For a running scene: Draw frames for the start, middle, and end of the run before doing the in-betweens.

7. Inbetweens and Secondary Action

- Now you add the "in-between" frames that smooth the motion between keyframes. Add:
  - Facial expressions
  - Hair/cloth movement
  - Gestures (secondary actions)

8. Timing and Spacing

- Adjust the timing of frames to make the animation feel natural. Timing affects:
  - Speed
  - Weight
  - Emotion

9. Cleanup and Coloring

- Once animation is solid:
  - Clean up lines (if 2D).
  - Color characters and backgrounds.
  - Add shading if needed.

10. Lighting, Rendering, and Effects (for 3D or polished work)

- In 3D: Add lights, shadows, and camera depth.
- In 2D: Add effects like glow, blur, fog, particles, etc.

11. Compositing and Sound Design

- All layers (characters, effects, backgrounds) are combined, synced with:
  - Dialogue
  - Sound effects
  - Music
- Use After Effects, Nuke, Blender, or DaVinci Resolve.

12. Final Output

- Export the final animation as a video file (MP4, MOV, etc.) and review for tweaks.

Summary

Step	Purpose
1. Storyboarding	Plan visuals & shot flow
2. Script & Dialogue	Add narrative or spoken content
3. Animatic	Test timing and pacing
4. Background/Layout Design	Establish environment
5. Character Design/Rigging	Build characters for motion
6. Keyframing/Blocking	Animate major poses
7. Inbetweens/Detail	Add fluidity and depth
8. Timing & Spacing	Adjust speed and realism
9. Cleanup & Coloring	Finalize visuals
10. Effects & Rendering	Add lighting, shading, special effects
11. Compositing & Sound	Merge all visuals and audio
12. Export Final Sequence	Produce finished video

Animation Languages

- JavaScript
  - Use: Animating elements on websites (2D/3D).
  - Libraries/Frameworks:
    - GSAP (GreenSock Animation Platform): Smooth, high-performance web animation.
    - Three.js: 3D animations in the browser.
    - Anime.js, Mo.js: For smooth vector and DOM animations.
  - Example: Animate a div box moving across the screen.
- HTML + CSS (Animations & Transitions)
  - Use: Basic UI/UX animations like fade-ins, button hovers, loaders.
  - CSS3 Features: @keyframes, transform, transition
  - Limitations: No logic; used for simple timeline-based effects.

Animation Languages

- C# (with Unity)
  - Use: 2D/3D game animations, character rigging, camera moves.
  - Tools: Unity Animator + Scripting via C#.
- C++ (with Unreal Engine or Custom Engines)
  - Use: High-performance 3D animations, physics-based motion.
  - Tools: Unreal Engine Blueprints + C++ for custom behaviors.
- Lua
  - Use: Scripting animations in games like Roblox, WoW, or Corona SDK.

Animation Languages

- Swift (iOS) / Kotlin (Android)
  - Use: Animations in mobile apps—transitions, gestures, UI feedback.
- React Native / Flutter (Dart)
  - Use: Cross-platform apps with animated widgets and gestures.

Animation Languages

- Python
  - Use Cases: Tool scripting in animation software (Blender, Maya, Houdini).
  - Example: Automating motion or creating procedural animations in Blender.

Specific Animation Languages

- ActionScript (Adobe Flash/Animate)
  - Now legacy, but used to animate and control interactive Flash content.
- Mel / Python (Autodesk Maya)
  - MEL: Maya Embedded Language—used to automate tasks and control animation scenes.
  - Python: Widely used now for scripting in Maya and Blender.
- GDScript (Godot Engine)
  - A Python-like language for scripting animations and gameplay in the Godot engine.
- Processing (Java-based)
  - Simplified Java-based language/environment for coding visual animations and art.

Keyframe

- A keyframe, also written as “key frame,” is something that defines the starting and/or ending point of any smooth transition.
- That something can be a drawing in animation or a particular frame of a shot when dealing with film or video.
- Any shot, animated or live-action, is broken down into individual frames.
- You can think of keyframes as the most important frames of a shot that set the parameters for the other frames and indicate the changes that will occur throughout as transitions.

Keyframe

- A keyframe is a specific frame in an animation timeline where a major position, pose, or value is defined.
- It marks the starting or ending point of a smooth transition.
- In between keyframes, the software or animator fills in the motion—this is called tweening (in digital animation) or inbetweens (in traditional animation).

Keyframe : Features

- Important individual frames from within a shot
- Keyframes exist in animation and live-action
- Sets a start/stop point for a transition

Keyframe : Origin

- These days, the word keyframes is often associated with video editing, but they originated in animation long before digital video editing.
- However, if you are familiar with keyframes in the context of editing, then you might already have a pretty good idea as to what is a keyframe in animation.

Keyframe

- Think of it like this:
- Imagine a flipbook:
  - Frame 1: A character standing.
  - Frame 10: The character is jumping in the air.
- Those two frames (1 and 10) are keyframes. What happens in between (frames 2–9) is the motion that connects the two poses.

Keyframe : Where?

- 2D Animation
  - Character poses, facial expressions, movements
- 3D Animation
  - Object/character position, rotation, scaling
- Motion Graphics
  - Text movement, opacity, scaling, transitions
- Video Editing
  - Audio levels, filter changes, video effects
- Game Dev (Unity)
  - Animating camera, player actions, UI transitions

Keyframe : Types

- Position Keyframe –
  - Moves an object from one place to another.
- Rotation Keyframe –
  - Rotates an object over time.
- Scale Keyframe –
  - Makes something grow/shrink.
- Opacity Keyframe –
  - Fades something in or out.
- Custom Property Keyframes –
  - Controls anything, like a character's arm bend or light color.

Tweening (Inbetweens)

- Between two keyframes, the software automatically calculates the transition:
  - Linear: Constant speed.
  - Ease In/Out: Starts slow or ends slow (more natural).
  - Custom Curves: You can create your own motion paths.

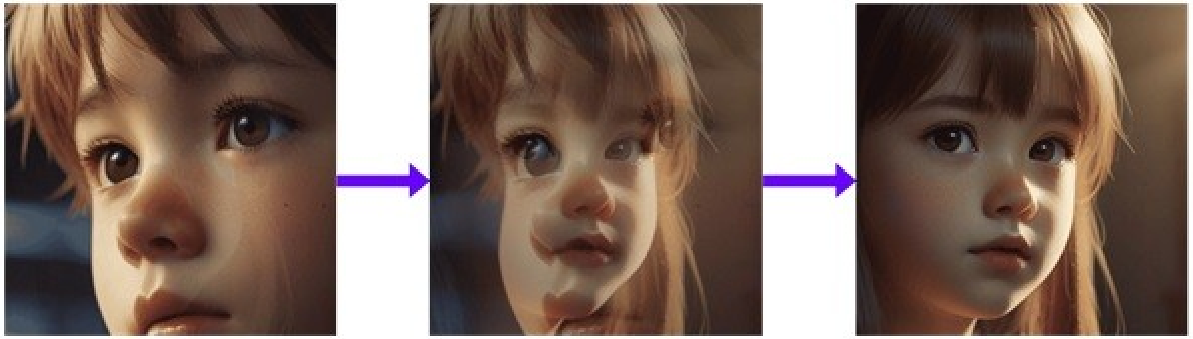
Morphing

- Morphing is a kind of animation that is used on images to gradually transform them into another image.
- It creates a smooth transition between two different objects, shapes, or faces.
- This technique is widely used in movies, advertisements, and video games to make engaging and visually attractive animations.

Morphing

- The morphing is used for transforming one image into another in a smooth, continuous manner.
- The term "morphing" comes from the Greek word "Metamorphosis". This means transformation or change in shape, form, or appearance.
- This technique is useful in animation to smoothly transition between different shapes or images.
- Morphing is commonly applied in computer graphics, especially in movies and video games.
- It gives for seamless transformations that create dynamic visuals.

Morphing



Morphing : Where?

- Film/TV
  - Face swaps, creature transformations (Terminator 2)
- 2D Animation
  - Logos or shapes smoothly transforming
- 3D Animation
  - Character transformations, object evolution
- Motion Graphics
  - Text or icons morphing for transitions
- Apps/UX Shape shifting animations (buttons morph into menus)

Morphing : Types

- Image Morphing
  - Gradually blends pixels of one image into another.
  - Often uses key points (landmarks) to align features.
  - Tools: After Effects, Adobe Premiere, FantaMorph, MorphX.

Morphing : Types

- Vector Morphing
  - Works with vector shapes like SVGs or drawn paths.
  - The anchor points and curves of Shape A are animated to match those of Shape B.
  - Tools: Adobe Animate, After Effects, SVGator, Lottie, Figma Smart Animate.

Morphing : Types

- 3D Morphing (Shape Keys / Blend Shapes)
  - Common in 3D modeling/animation.
  - Transforms one 3D model into another using blend shapes or morph targets.
  - Tools: Blender, Maya, 3ds Max, Unity.

Morphing : Workflow

- Choose or create two shapes/images.
- Define matching points (especially for faces or complex forms).
- Set keyframes for the start and end states.
- Apply interpolation (software handles the in-between).
- Tweak timing and easing to control flow and speed.

Morphing : Examples

- Terminator 2 (T-1000): Iconic liquid metal morphs.
- Michael Jackson’s “Black or White”: Famous face morphing.
- Nike Ads: Logos or shoes morphing between shapes and textures.
- Lottie Animations: App icons morphing into other icons during loading or navigation.

Motion Specification

- Motion specification refers to the detailed planning and description of how objects move in an animation or interactive experience.
- It defines:
  - What moves
  - How it moves
  - When it moves
  - Why it moves
- Basically, it’s the blueprint of motion, just like a script is a blueprint for dialogue.

Motion Specification Includes

- Object/Element
  - What is being animated (e.g., button, character, icon, shape)
- Type of Motion
  - Translation (move), rotation, scaling, fading, morphing, bouncing, etc.
- Duration
  - How long the motion lasts (e.g., 0.3s, 2s)
- Timing Function
  - How speed changes over time (ease-in, ease-out, linear, custom curves)

Motion Specification Includes

- Delay
  - When the motion starts relative to other events
- Sequence/Order
  - Whether the motion is simultaneous, staggered, or chained
- Triggers
  - What causes the motion (e.g., hover, click, scroll, user interaction, time-based)
- Direction
  - Which direction the motion occurs (e.g., left to right, top to bottom)
- Purpose/Feedback
  - What the motion is communicating (e.g., success, transition, emphasis)

Motion Specification: Where?

- In UI/UX Design:
  - Microinteractions (button presses, menu reveals)
  - Transitions between screens or states
  - Onboarding animations
- In Animation Production:
  - Defining how a character moves from pose A to B
  - Coordinating multiple elements in a scene
- In Game Development:
  - Character actions (jump, run, idle)
  - Camera movements
  - Environmental animations (like wind or lighting effects)

Motion Specification: Example (UX)

- Element: Button
- Trigger: On Hover
- Type: Scale Up
- Duration: 200ms
- Timing Function: Ease-out
- Effect: Scale from 1 to 1.1
- Purpose: Indicate interactivity and focus

Motion Specification: Example (2D)

- Character: Main Hero
- Action: Wave Hand
- Keyframes:

  Frame 0: Arm down (rest)

  Frame 10: Arm halfway up

  Frame 20: Full wave
- Ease: Ease-in at start, ease-out at end
- Total Duration: 1 second
- Secondary Motion: Hair and shirt follow-through

Controlling Animation

- Controlling animation refers to the various techniques used to start, stop, manipulate, or respond to animation—either manually (by an animator) or programmatically (using code or logic).

Controlling Animation

- 1. Timeline-Based Control
- Used In: Traditional 2D/3D animation software (like After Effects, Blender, Maya)
- Features:
  - Animations are sequenced over time on a timeline.
  - Keyframes are used to set values (position, rotation, etc.) at certain times.
  - Animators manually control timing, easing, and layering.
- Good for: Detailed motion design, character animation
- Limitation: Not reactive or interactive.

Controlling Animation

- Script-Based or Code-Driven Control
- Used In: Web animation (JavaScript), games (C#, C++, Python), UI animation
- Features:
  - You use code to control animation states, triggers, and behaviors.
  - Can respond to user inputs, conditions, or physics.
- Examples:
  - requestAnimationFrame() in JavaScript
  - Animator.Play("Jump") in Unity (C#)
  - Event listeners (e.g., hover, scroll, click)
- Good for: Interactive, dynamic, and conditional animations
- Limitation: Requires programming knowledge

Controlling Animation

- State Machine Control
- Used In: Game engines (Unity, Unreal), apps
- Features:
  - Animations change based on states (Idle → Run → Jump).
  - Transitions are defined by conditions or triggers.
  - Visual tools (like Unity’s Animator Controller) are often used.
- Good for: Character behavior, game logic, UI animations
- Limitation: Can get complex with many states

Controlling Animation

- Event-Driven Control
- Used In: Web apps, mobile UI, games
- Features:
  - Animation is triggered by events (e.g., click, hover, scroll, gesture).
  - Often paired with scripting or frameworks.
- Examples:
  - On hover: Button scales up
  - On scroll: Text fades in
  - On click: Modal slides in
- Good for: Responsive UI/UX
- Limitation: Requires careful planning to avoid overload

Controlling Animation

- Physics-Based Control
- Used In: Advanced animation systems, games, motion design
- Features:
  - Animation is driven by physics rules like gravity, friction, or spring tension.
  - Creates more natural or organic motion.
- Examples:
  - Ball bounce reacts to surface material
  - Object springs into position
- Good for: Realism, immersive interactivity
- Limitation: Harder to control exact timing or behavior

Controlling Animation

- Looping and Playback Control
- Options:
  - Looping: Repeats animation (e.g., loading spinner)
  - Play Once / Reverse / Ping-Pong: Controls how animation plays
  - Pause/Resume: Useful in games or interactive content
- Good for: Repeating animations, sequences, idle loops

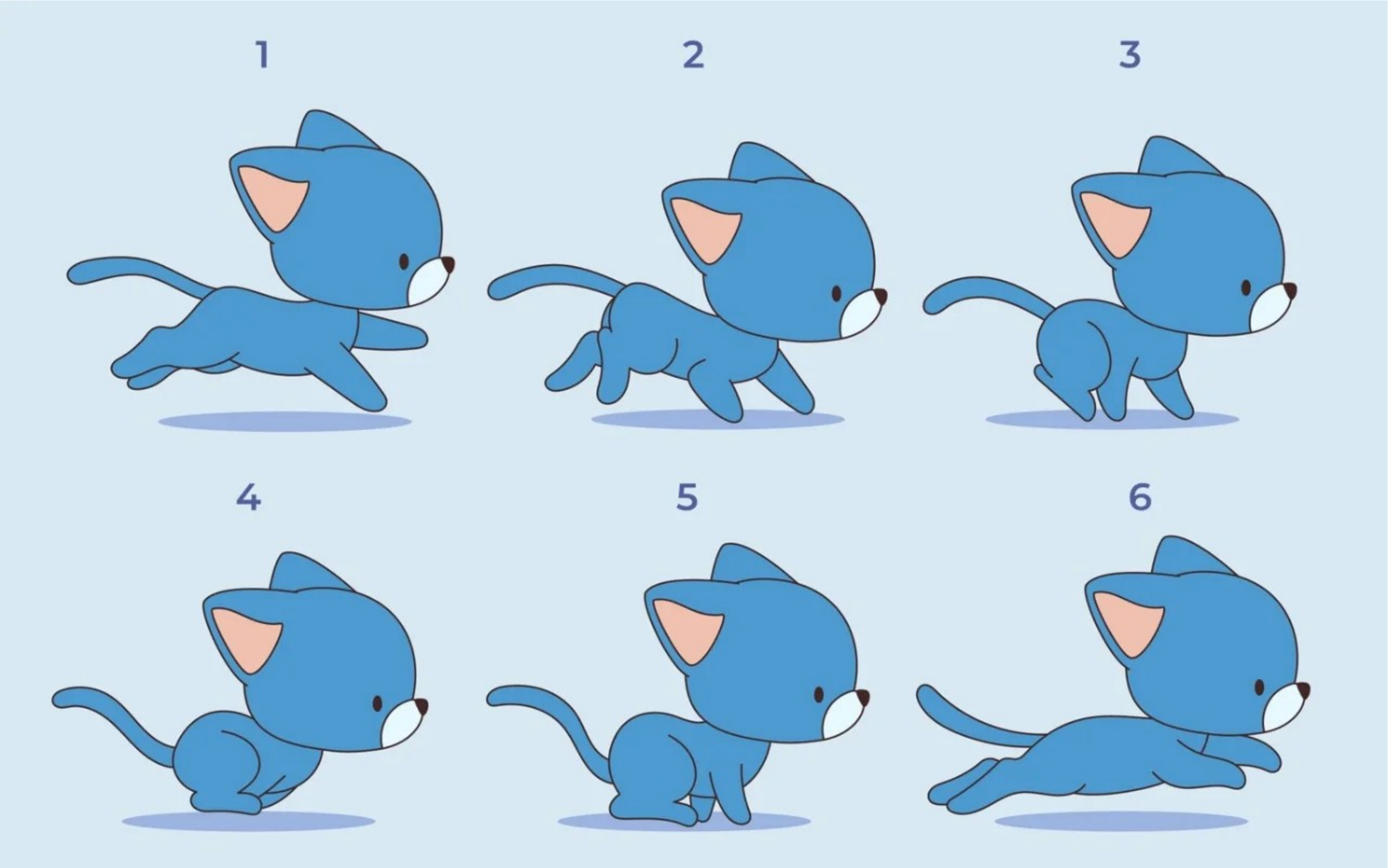
Controlling Animation

- User-Driven Control (Manual or Gesture-Based)
- Features:
  - Animation responds directly to user input, not just events.
  - Used in sliders, drag-and-drop UIs, gesture-based apps.
- Examples:
  - Scrubbing through a timeline
  - Drag-to-reveal menus
  - Pinch-to-zoom animations
- Good for: High interactivity
- Limitation: Needs robust input handling

Frame-by-Frame Animation

- Frame-by-frame animation (also known as traditional animation or classical animation) is a technique where each frame of the animation is drawn individually.
- This method gives animators complete control over every movement, allowing for expressive, fluid, and dynamic results.

Frame-by-Frame Animation



Frame-by-Frame Animation

- Traditional Hand-Drawn Animation (2D)
  - Process: Artists draw each frame by hand on paper or digitally.
  - Tools: Pencil, paper, or drawing tablets and software like Toon Boom, TVPaint, or Adobe Animate.
  - Example:
    - Disney classics like The Lion King or Aladdin.

Frame-by-Frame Animation

- Cel Animation
  - Process: Drawings are done on transparent sheets (cels), then layered over static backgrounds.
  - Used in: Old-school cartoons, e.g., Snow White.
  - Advantage: Saves time by reusing backgrounds or repeated character poses.

Frame-by-Frame Animation

- Stop-Motion Animation
  - Process: Physical objects (clay, puppets, cutouts) are photographed frame by frame.
  - Subtypes:
    - Claymation: Made with clay models (e.g., Wallace and Gromit).
    - Puppet animation: Using articulated puppets (e.g., Coraline).
    - Cut-out animation: Flat characters and props (e.g., early South Park).
  - Software: Dragonframe, Stop Motion Studio.

Frame-by-Frame Animation

- Rotoscoping
  - Process: Tracing over live-action footage frame by frame.
  - Used for: Realistic motion, sometimes in visual effects.
  - Examples:
    - A Scanner Darkly, older Star Wars lightsaber effects.

Frame-by-Frame Animation

- Digital Frame-by-Frame Animation
  - Process: Done digitally but follows the same principle of drawing each frame.
  - Software: Adobe Animate, Krita, RoughAnimator, Procreate (on iPad), etc.
  - Flexibility: Easier editing, onion skinning (seeing previous/future frames), layers.

Real time animation techniques

- Real-time animation techniques allow animations to be generated and rendered instantly as they happen—meaning the animation responds immediately to input without the need to pre-render each frame.
- These techniques are key in video games, interactive media, virtual production, VR/AR, and live performances.

Real time animation techniques

- Skeletal Animation (Bone Rigging)
  - How it works: A character is rigged with a skeleton of interconnected bones. Animations are created by moving the bones, not redrawing the whole character.
  - Used in: Almost all 3D games and animated characters.
  - Software: Unity, Unreal Engine, Blender, Maya.
  - Why it's real-time: The skeleton deforms the mesh instantly based on the rig’s position—lightweight and efficient.

Real time animation techniques

- Motion Capture (MoCap)
  - How it works: Actors wear suits with sensors; their movements are tracked and applied to digital characters in real time.
  - Used for: Real-time performances, games, virtual influencers (like Lil Miquela), and virtual production (The Mandalorian).
  - Tech: Vicon, Rokoko, Xsens, Kinect, iPhone ARKit (for face capture).
  - Real-time use: Can be streamed directly into engines like Unreal for live control of characters.

Real time animation techniques

- Performance Capture / Facial Capture
  - How it works: Tracks facial expressions and voice in real time using cameras or mobile devices.
  - Tools: iPhone TrueDepth camera (via ARKit), Faceware, Live Link Face (Unreal).
  - Used in: VTubing, livestream avatars, real-time character interaction.

Real time animation techniques

- Live Puppeteering / Virtual Puppets
  - How it works: Animators control characters using gamepads, keyboards, or MIDI devices in real-time.
  - Example: Adobe Character Animator lets users control cartoon puppets with facial expressions, voice, and webcam input—great for livestreams or YouTube content.
  - Benefit: No rendering time; perfect for fast production and live shows.

Real time animation techniques

- Real-Time Game Engines (Unity / Unreal Engine)
  - Role: These engines combine all the above and handle real-time rendering, physics, lighting, and animation.
  - Why it's real-time: They render 3D scenes at 30–120+ FPS, reacting to user input, camera changes, or character actions instantly.
  - Used for: Games, metaverse, VR/AR, virtual production, interactive art.

Real time animation techniques

- Inverse Kinematics (IK) & Procedural Animation
  - IK: Calculates joint rotations automatically so limbs reach targets naturally (e.g., feet stay on uneven ground).
  - Procedural Animation: Animations generated by code or physics rather than pre-made clips (e.g., ragdoll physics, aim/look direction).
  - Benefit: Adapts to the environment or player actions dynamically.

Real time animation techniques

- Virtual Production & LED Volume (like in The Mandalorian)
  - How it works: Real-time engines render environments live on massive LED walls around physical sets.
  - Key tech: Unreal Engine, camera tracking, MoCap integration.
  - Why it matters: Directors and actors see final lighting and environments live instead of relying on green screen and post-production.

Conclusion

- Animation techniques continue to evolve, blending traditional artistry with cutting-edge technology.
- Both frame-by-frame and real-time methods have unique strengths—one emphasizes detail, the other interactivity.
- Modern tools and software have made animation more accessible to creators of all levels.
- Animation is a powerful medium for storytelling, education, entertainment, and immersive experiences across industries.

Thank you

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