

UNIT 5

Animation and Virtual Reality

(10 Hours) — Computer Graphics and Animation (CAC305)

Animation is the process of creating an illusion of motion by displaying a rapid sequence of still images, each slightly different from the last. This unit introduces the fundamental principles of animation, the working environment of Adobe Flash/Animate — a widely used tool for creating vector-based animations — and the core techniques used to bring static graphics to life, including frame-by-frame animation, tweening, and masking. The unit concludes with an introduction to virtual reality, a technology closely related to computer graphics and animation.

5.1 Basic Principles of Animation and Types of Animation

Animation is the technique of displaying still images in rapid succession so that the human eye perceives continuous motion. This illusion relies on a phenomenon called persistence of vision — the human eye retains an image for a fraction of a second after it disappears, so a sequence of slightly different images shown quickly enough (typically 12–30 frames per second or more) blends into apparent movement.

Types of Animation

Type	Description
Traditional (Cel) Animation	Each frame is hand-drawn on a transparent celluloid sheet; the classical hand-drawn cartoon technique
Frame-by-Frame Animation	Every frame of the animation is created individually, giving the animator full control over each frame
2D (Vector/Tween-based) Animation	Objects are animated by interpolating between keyframes using software (e.g. Flash/Animate)
3D Computer Animation	Objects are modeled in 3D and animated by manipulating a virtual skeleton, camera, and lighting
Stop-Motion Animation	Physical objects or models are photographed one frame at a time with small changes between shots
Motion Graphics	Animated graphic design elements such as text, logos, and shapes, commonly used in titles and advertisements

Basic Principles of Animation

A set of twelve foundational principles, originally developed by Disney animators, is widely used to make animation appear more natural, believable, and appealing. The key principles include:

Principle	Purpose
Squash and Stretch	Gives a sense of weight and flexibility to an object as it moves
Anticipation	Prepares the viewer for a major action by a small opposite movement beforehand
Staging	Presents an idea so clearly that it is unmistakable to the viewer
Straight Ahead & Pose to Pose	Two different approaches to drawing frames — sequentially, or by key poses first
Follow Through & Overlapping Action	Parts of a body or object continue moving after the main motion stops
Slow In and Slow Out	Movements start slowly, speed up, and slow down again near the end
Arcs	Most natural movement follows a curved (arc) path rather than a straight line
Secondary Action	Adds supporting actions that emphasize the main action
Timing	Controls the number of frames used for an action, affecting its speed and weight
Exaggeration	Amplifies an action or expression to make it more dynamic and expressive
Solid Drawing	Ensures objects have volume, weight, and balance in 3D space
Appeal	Makes a character or object visually pleasing and engaging to watch

Note: These principles apply not only to traditional hand-drawn animation but also to computer-based 2D/3D animation, since they are based on how real-world motion is perceived as natural and convincing.

5.2 Introduction to the Flash Interface

Adobe Flash (now Adobe Animate) is a widely used authoring tool for creating vector-based animations, interactive content, and multimedia for the web and other platforms. Its interface is organized into several key areas that work together during the animation process.

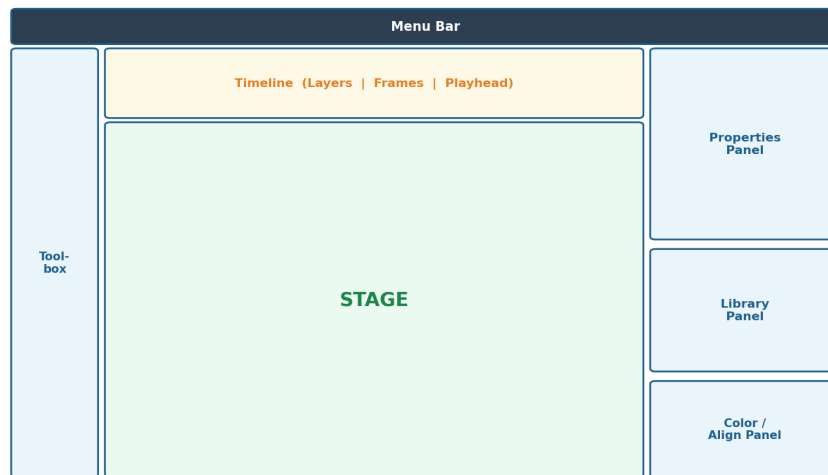


Figure 5.1 — Basic layout of the Flash/Animate interface

Main Interface Components

Component	Function
Menu Bar	Provides access to all commands, organized under File, Edit, View, Insert, Modify, and other menus
Toolbox	Contains drawing and selection tools such as the Selection, Line, Oval, Rectangle, Pen, and Brush tools
Stage	The rectangular area where visible content of the movie is placed and composed
Timeline	Organizes and controls the content of a document over time using layers and frames
Panels	Floating or docked windows (Properties, Library, Color, Align, etc.) used to view and change settings

The Stage is where all visible artwork for the animation is placed, while the Timeline below or beside it (organized into layers and frames) determines what content appears and when, over the duration of the movie.

5.3 Setting Stage Dimensions, Working with Panels, Panel Layouts

Setting Stage Dimensions

The stage size defines the visible area of the final movie. It is set through the Document Properties (or Properties panel) and typically includes:

- Stage dimensions (width × height, in pixels) — defines the visible movie area.
- Background color — the color displayed behind all stage content.

- **Frame rate (fps)** — the number of frames displayed per second, which controls the speed of the animation.
- **Ruler units** — pixels, inches, points, centimeters, or millimeters, used for precise placement of objects.

Note: A higher frame rate produces smoother motion but increases file size and processing requirements; a common default is 24 fps.

Working with Panels

Panels provide access to specific categories of tools and settings. Commonly used panels include:

Panel	Purpose
Properties	Displays and edits properties of the currently selected object, frame, or document
Library	Stores and organizes reusable assets such as symbols, imported images, and sounds
Color	Sets fill and stroke colors, gradients, and transparency (alpha)
Align	Aligns and distributes multiple selected objects relative to each other or the stage
Timeline	Displays layers and frames used to sequence and organize animation content
Actions	Provides an editor for adding ActionScript code to frames, objects, or buttons

Panel Layouts

Panels can be docked to the sides of the workspace, grouped into tabbed sets, floated freely, or collapsed to icons to save screen space. Most authoring environments allow users to save a custom arrangement of panels as a named workspace layout, which can be quickly restored later — useful for switching between tasks such as drawing, animating, or scripting.

5.4 Layers & Views

Layers act like transparent sheets stacked on top of one another, allowing different parts of an animation to be organized and animated independently without affecting content on other layers. Objects on a layer higher in the stack visually appear in front of objects on layers below it.

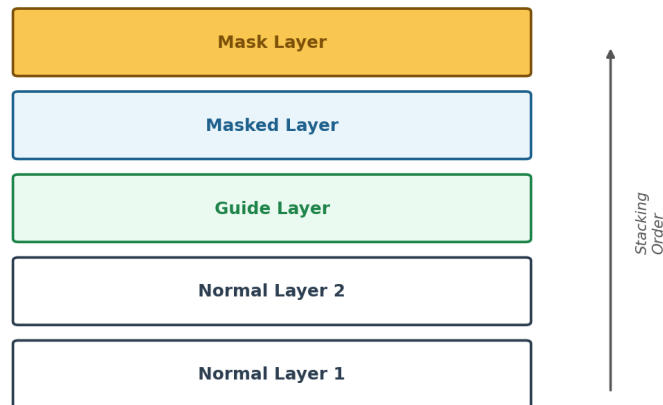


Figure 5.2 — A typical layer stack, from a background normal layer up to a mask layer at the top

Types of Layers

Layer Type	Purpose
Normal Layer	The default layer type used to hold standard artwork and animation
Guide Layer	Used to draw reference paths or guides that are not visible in the final output
Motion Guide Layer	Defines a path along which an object on an associated layer is animated
Mask Layer	Defines a shape that reveals only the corresponding portion of the layer(s) below it
Folder (Layer Group)	Organizes multiple layers into a collapsible group for easier management

Layer Operations

- Add, delete, rename, and reorder layers to organize the content of a movie.
- Lock a layer to prevent accidental editing while working on other layers.
- Show/hide a layer to focus on specific content during editing.
- Change the outline color of a layer to view its content as outlines only, useful when working with complex artwork.

Views

View options let the animator control how the stage and timeline content are displayed while working, including zooming in/out on the stage, switching between outline and normal view for layers, and using onion skinning to see faint outlines of neighboring frames — which greatly helps when drawing frame-by-frame animation.

5.5 Shaping Objects — Overview of Shapes, Drawing & Modifying Shapes

Vector shapes form the basic building blocks of artwork created within an animation authoring tool. Shapes are described mathematically (as paths made of lines and curves) rather than as pixels, which allows them to be scaled without loss of quality.

Overview of Shapes

A shape generally consists of two components:

- **Stroke** — the outline or border of a shape, with its own color, thickness, and style.
- **Fill** — the interior color or pattern (solid color, gradient, or bitmap) inside the shape's boundary.

Drawing Tools

Tool	Use
Line Tool	Draws straight line segments
Oval Tool	Draws ellipses and circles
Rectangle Tool	Draws rectangles and rounded rectangles
Pencil Tool	Freehand drawing of lines and curves
Pen Tool	Draws precise straight and curved paths using anchor points
Brush Tool	Paints broad strokes of color, similar to a paintbrush

Modifying Shapes

Once drawn, shapes can be modified using several tools and techniques:

- **Selection Tool** — selects and reshapes segments of a shape's outline by dragging.
- **Subselection Tool** — displays and edits individual anchor points and their curve handles.
- **Free Transform Tool** — scales, rotates, skews, and distorts a shape or group of shapes.
- **Envelope / Distort Modifiers** — reshape an object using a surrounding grid of control points for more complex deformation.
- **Combine/Merge operations** — union, intersect, and punch (subtract) operations combine multiple shapes into new ones.

5.6 Bitmap Images & Sounds

Working with Bitmap Images

In addition to vector shapes, animation projects often use bitmap (raster) images — images made up of a grid of pixels, such as photographs or scanned artwork. Bitmaps are imported into the project's Library and can then be placed on the stage.

- Importing — bitmap files (e.g. JPEG, PNG, GIF) are imported into the library for reuse throughout the project.
- Using as a fill — a bitmap can be used to fill a vector shape, so the shape's outline acts as a mask for the image.
- Tracing a bitmap — converts a bitmap image into vector shapes that approximate its colors and outlines, reducing file size and enabling scalability.
- Breaking apart — converts a bitmap instance into editable vector fill/stroke data that can be reshaped like any other shape.

Working with Sounds

Sound files can be imported into the library and added to the timeline to accompany an animation, such as background music, sound effects, or voiceovers.

Sound Sync Type	Behavior
Event Sound	Plays independently once triggered, regardless of the timeline's playback (does not stop when the timeline stops)
Start Sound	Similar to Event, but will not restart a new instance if the sound is already playing
Stop Sound	Silences a specific sound that is currently playing
Streaming Sound	Synchronized to the timeline; the sound plays in step with the frames and stops when playback stops

Note: Streaming sound is generally preferred for animation that must stay tightly synchronized with dialogue or music, such as lip-sync animation, since it is tied directly to the frame timeline.

5.7 Animation — Principles, Frame-by-Frame Animation, Tweening, Masks

Within an authoring tool, animation is built primarily using two complementary techniques — frame-by-frame animation and tweening — along with special-purpose layers such as masks.

Frame-by-Frame Animation

In frame-by-frame animation, the content of every single frame is created individually as a distinct keyframe. This technique offers the greatest control and can produce complex, highly

detailed motion, but requires significantly more drawing effort and results in larger file sizes, since no frame content is calculated automatically.

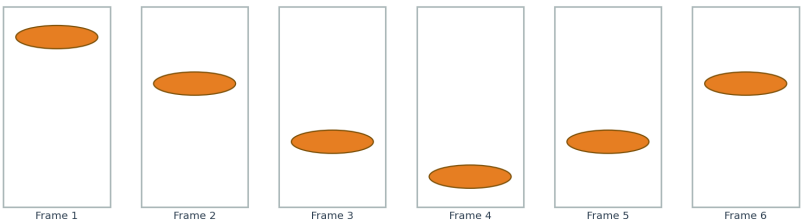


Figure 5.3 — Frame-by-frame animation: each frame is drawn as a separate, unique keyframe

Tweening

Tweening (short for 'in-betweening') is a technique where the animator defines only the starting and ending keyframes of an animation, and the software automatically calculates and generates the intermediate frames between them.

Tween Type	Description
Motion Tween	Animates the position, scale, rotation, color, and other properties of a symbol instance smoothly between keyframes
Classic Tween	An older motion-tween workflow requiring separate keyframes on the timeline with interpolation applied between them
Shape Tween	Morphs one vector shape smoothly into another shape between two keyframes

Frame-by-Frame:



Every frame is drawn individually (a unique keyframe)

Tweening:



Only start & end keyframes are drawn; software generates the frames in between

Figure 5.4 — Comparison of frame-by-frame animation (every frame is a keyframe) and tweened animation (only start and end keyframes are defined)

Note: Tweening greatly reduces production time and file size compared to frame-by-frame animation, but is best suited to smooth, continuous transformations rather than highly complex or irregular motion.

Masks

A mask layer uses the shape(s) drawn on it to define a 'window' through which the content of the linked layer(s) beneath it is revealed. Only the parts of the masked layer that fall within the boundary of the mask shape are visible; everything else is hidden.

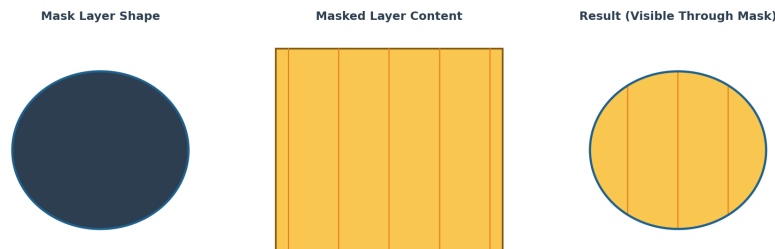


Figure 5.5 — A mask shape (left), the full content of the masked layer (center), and the resulting visible content (right)

Masking is commonly used to create effects such as spotlight reveals, wipe transitions, and text or shapes that appear to be 'filled' by moving content underneath them. A mask layer can itself be animated (e.g. tweened), which animates the revealed region over time.

Steps to Create a Basic Mask

1. Create a layer containing the content to be revealed (the masked layer).
2. Add a new layer above it and draw the shape that will act as the mask.
3. Right-click the mask layer and choose the option to set it as a Mask layer.
4. The software automatically links the layer below to the mask and locks both layers to preview the masking effect.
5. Unlock the layers to continue editing; only the overlapping area between the mask shape and the masked layer's content will be visible in the final output.

5.8 Introduction to Virtual Reality

Virtual Reality (VR) is a computer-generated simulation of a three-dimensional environment that a user can explore and interact with in a seemingly real or physical way, typically using specialized electronic equipment. VR aims to immerse the user's senses — particularly sight and hearing, and sometimes touch — so that the simulated environment feels convincingly present.

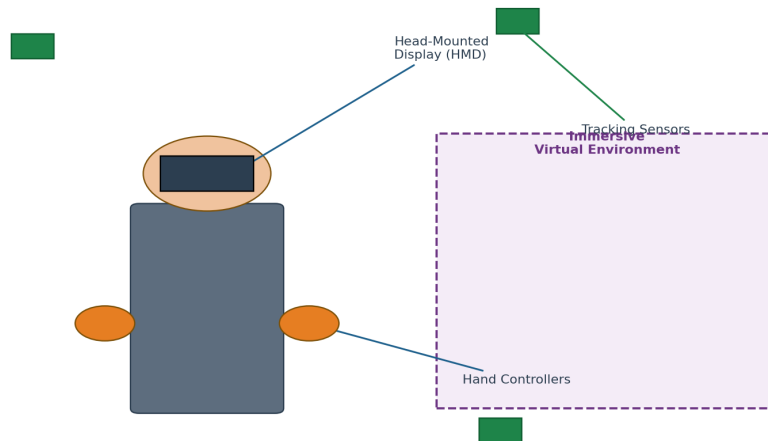


Figure 5.6 — A typical virtual reality setup, showing a head-mounted display, hand controllers, and external tracking sensors

Key Components of a VR System

Component	Function
Head-Mounted Display (HMD)	Worn on the head; displays stereoscopic images to create a 3D immersive visual experience
Tracking Sensors	Track the position and orientation of the user's head and body to update the view in real time
Hand Controllers	Allow the user to interact with and manipulate objects within the virtual environment
Haptic Devices	Provide touch/force feedback, enhancing the sense of physical presence in the virtual world
Processing Unit	A computer, console, or mobile device that renders the virtual environment in real time

Types of Reality Technologies

Term	Description
Virtual Reality (VR)	Fully immersive; the user's view of the real world is completely replaced by a simulated environment
Augmented Reality (AR)	Overlays computer-generated content onto the user's view of the real world
Mixed Reality (MR)	Blends real and virtual elements so that they can interact with each other in real time

Applications of Virtual Reality

- Gaming and interactive entertainment.
- Education and training simulations (e.g. flight simulators, medical training).
- Architecture and virtual walkthroughs of building designs.
- Virtual tourism and cultural heritage exploration.
- Therapy and rehabilitation applications in healthcare.

Note: Because VR relies heavily on real-time 3D rendering, transformation, and viewing techniques, it builds directly on the core computer graphics concepts covered throughout this course.

Key Takeaways

- ✓ Animation creates the illusion of motion using persistence of vision, and spans several types including traditional, frame-by-frame, 2D, 3D, and stop-motion animation.
- ✓ The twelve basic principles of animation (squash & stretch, timing, arcs, and others) make computer and hand-drawn animation appear more natural and appealing.
- ✓ The Flash/Animate interface is organized around the Stage, Timeline, Toolbox, and Panels, which together support drawing, layering, and sequencing animated content.
- ✓ Layers organize content into independent stacked levels, including normal, guide, and mask layer types, controlling stacking order and visibility.
- ✓ Frame-by-frame animation defines every frame individually, while tweening (motion, classic, and shape tweens) automatically generates the frames between defined keyframes.
- ✓ A mask layer reveals only the portion of an underlying layer that falls within the mask's shape, enabling reveal and transition effects.
- ✓ Virtual reality immerses users in a simulated 3D environment using components such as HMDs, tracking sensors, and controllers, and is closely related to AR and MR technologies.

— End of Unit 5 —