CHAPTER

9. Animation

COM 205
MULTIMEDIA APPLICATIONS

CHAPTER HIGHLIGHTS

- Animation basics
- Traditional animation techniques
- 2-D animation techniques:
  - Keyframe
  - Tween
  - Programmed

- 3-D animation:
  - Motion capture
  - Kinematics
  - Animating with physics
- Guidelines for animation in multimedia

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PINNACLE OF MODERN MULTIMEDIA

- Animation draws inspiration from each of the other media.

- Computer is a partner in creative expression.
  - It lowered costs and increased ease of creating animation.
  - It supports creative expression through:
    - Interactivity
    - 3-D sensory experience
    - Embodiment and implementation of rules of behavior.

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ANIMATION BASICS

- Animation: rapidly displayed sequence of individual, still images.

- Made possible by "persistence of vision."
  - Images formed on the retina persist for a short period of time after stimulus has disappeared.
  - This physical memory of the retina produces the illusion of motion.

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ANIMATION BASICS

- Flipbook technique
  - Still images showing a different stage of motion are created on each page.
  - Pages are "flipped" in rapid succession to view the motion.
  - Animation basics used in flipbook:
    - Quality of motion is based on rate of display.
    - Speed is based on differences between images.
    - Onionskinning: a technique used to draw new image based on the previous image.
    - Registration: physically aligns images with one another.

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TRADITIONAL ANIMATION

- Film based process
  - Images are photographed and recorded as separate frames on long strip of transparent film.
  - Film passed in front of light source and animation appeared on a screen.
- Film enhanced possibilities of animation.
  - Multiple reels allowed longer animations.
  - Projectors displayed images at reliable frame rates.
  - Animators could add sound to the motion.

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CHALLENGES OF TRADITIONAL ANIMATION

- Number of images to create.
  - 24 frames per second requires 1,440 individual still images for each minute of animation.
  - Methods to generate images include:
    - Shooting on twos cuts number of images in half.
    - Cycle of images can be reused to extend repetitive motion.
    - Holds produce sequence of identical drawings to extend a particular state or action.

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CHALLENGES OF TRADITIONAL ANIMATION

- Artistic strategies to create realistic world require:
  - Awareness of how things move in the world.
    - Ease-in and ease-out address the physics of motion.
    - Overshooting a resting point addresses kinetic energy of motion.
    - Different components of objects move independently of one another (overlapping motion).
  - Exaggerate motion for dramatic effect using:
    - Variations in speed
    - Stretch and squash.

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Traditional Techniques

- Strategies for achieving motion have been applied to:
  - Paper cut-outs
  - Clay figurines
  - Puppets
  - Natural objects photographed, reposed and re-photographed.

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CEL ANIMATION

- Perfected and made popular by Disney studios.
  - Cel: drawings of individual frames made on sheets of celluloid.
  - Drawings were then photographed to produce the animated film.
- Technique that directly influenced development of digital animation.

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CEL ANIMATION ADVANTAGES

- Artists saved drawing time.
  - Fixed components of a scene were drawn once and layered on the bottom of a stack of celluloid sheets.
  - Moving components were drawn separately and placed on top of the fixed scene components.
- Gave precise control over elements.
  - Individual cel layers could reproduce interdependent, complex motions.

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CEL ANIMATION ADVANTAGES

- Encouraged division of labor and promoted high artistic standards.
  - Master artists drew key frames or extremes.
  - Assistants drew the tweens.
  - Inkers transferred drawings from paper to celluloid.
  - Opaquers applied colors to the celluloid.
  - Additional specialists included:
    - Producers
    - Directors
    - Script writers
    - Audio specialists
    - Camera operators
    - Checkers.

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PRODUCING CEL ANIMATION

- Cost and complexity of creating animation required a carefully defined process.
  - Storyboard: sequence of drawings that sketch out content of major scenes in the production.
  - Pencil test: series of simple sketches that are photographed and projected to test the design of the animated sequences.
  - Scratch track: draft of animation's audio track.
  - Leica reel: working draft of the complete animation.

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PRODUCING CEL ANIMATION

- Uses specialized equipment in production process.
  - Specialized paints to convey proper hue.
  - Specialized camera and lighting to capture cels.
  - Devices to:
    - Track changes in paths of animated characters.
    - Align and hold the cels for camera shots.
    - Synchronize and edit the final film.
- Cel animation is complex, demanding, and expensive animation.
  - Computers dramatically improved the process.

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DIGITAL ANIMATION

2-D & 3-D Animation

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2-D ANIMATION

- Produced by mimicking basic traditional techniques such as:
  - Flipbook technique
  - Cutout animation technique
  - Rotoscoping
  - Cel animation
- Paint/draw programs are used to create the components.
- Animation software can sequence, set timing, transitions, and produce the final animation.

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DIGITAL CEL ANIMATION

- Animations are a series of individual frames.

  - Synchronized to one or more sound tracks.

  - Graphics arranged on layers.

  - Major changes identified in keyframes.

  - Illusion of motion produced as series of tweens.

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ANIMATION SOFTWARE

- Elements of Flash organization.

  - Timeline: horizontal row of frames.

  - Frames: have multiple layers in columns.

    - Layers have stacking order (background elements on lower layers, changing elements on upper layers)

  - Keyframes: define major changes in a frame.

  - Tweens: frames created automatically by software.

  - Onionskinning: assists in drawing changes from one frame to the next.

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ANIMATION SOFTWARE

- Frame-by-frame animation: each frame is manually drawn to reflect motion sequence.
    - Gives detailed control of each motion.
    - Time consuming process.
- Tween animation: computer generates in-between frames based on two designated key frames.
    - Motion tween
    - Path-based tween
    - Shape tween (morphing)
    - Size tween
    - Color tween
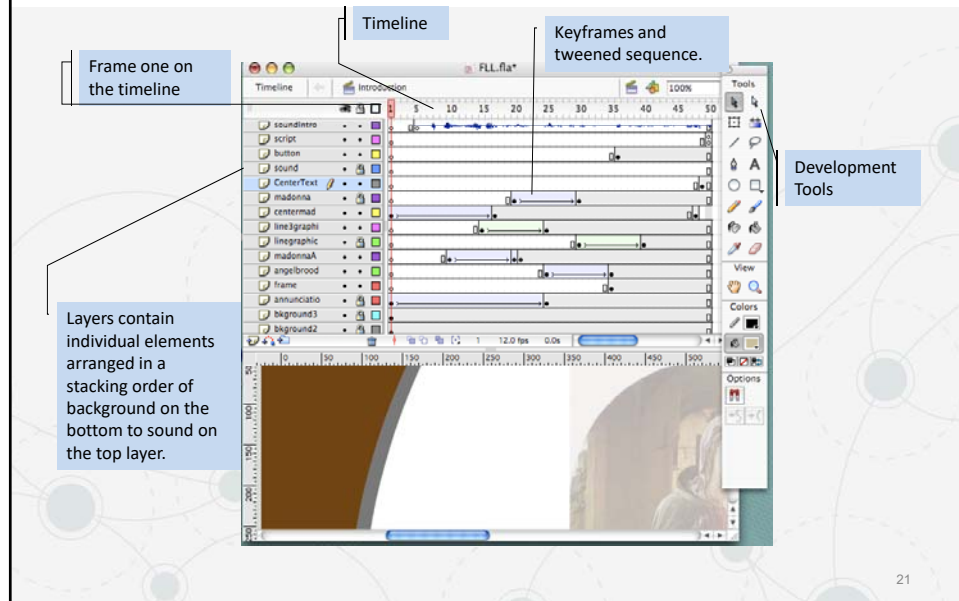   - Transparency tween

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ANIMATION SOFTWARE

- Provide tools to support animation process.
    - Image-editing tools
    - Alignment tools and grids to control placement
    - Text tools
    - Basic sound control
    - Strategies to support interactivity.

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FLASH DEVELOPMENT SCREEN

Timeline

Keyframes and tweened sequence.

Frame one on the timeline

Development Tools

Layers contain individual elements arranged in a stacking order of background on the bottom to sound on the top layer.

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PROGRAMMED ANIMATION

- Animators write commands and the computer generates the animation.
  - Requires knowledge of programming and mathematical techniques to specify motion.
- Advantages:
  - File sizes are smaller.
  - Animations load and play faster.
  - Reduces bandwidth and processor demands.
  - Efficient creation of different versions of animated sequence.

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PROGRAMMED ANIMATION

- Supports complex forms of interactivity.
  - Computer games take input from the user and animate the objects "on the fly."

- Scripting languages frequently used to generate programmed animations:
  - Lingo
  - Actionscript
  - Javascript

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3-D ANIMATION

- Elements of 3-D animation set in motion include:
  - Objects
  - Sounds
  - Cameras
  - Lights.

- Techniques are similar to 2-D animation:
  - Key frame
  - Tween motion.

- Complex motion may involve using models of humans and animals.

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MOTION CAPTURE

- Also called performance animation.
  - Technique of recording motion of actual objects and mapping these motions to a computer-generated animated character.
  - Performers have sensors to track the motion of various body parts as they create the action sequences.
- Used to capture complex natural motions that are difficult to create.

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FORWARD KINEMATICS

- Kinematics is study of motion of bodies or systems of bodies.
  - The motion of one part generates related motion in others.
- Animator must adjust all motion in all related parts of the body.
  - Simple to implement.
  - Models easily defined.
  - Computer processing is minimal.
  - Quality of motion depends on animator's skill.
  - Animation is time consuming process.

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INVERSE KINEMATICS

- Motion of one body part produces related motions in other body parts.
  - Simplifies animator's work and ensures consistent, realistic motion.
- Software embodies the knowledge of anatomical motion.
  - Requires innovative programming.
  - Demands more processing power than forward kinematics.
- Significantly reduces work of animator.

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ANIMATING WITH PHYSICS

- Software can automatically generate motions based on properties of object and laws of physics.
- Will free animators from more tedious tasks of 3-D animation and produce more realistic content.
  - Animators can concentrate on developing stories and characters.

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COMPLETING THE ANIMATION

- Rendering creates the final animation frames by applying:

  - The modeling

  - Surface definition

  - Scene composition as specified by animator

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RENDERING OPTIONS

Shrek 1 in 2001 used about 5 million CPU render hours.

Shrek 2 in 2004 used 10 million CPU hours

Shrek 3 in 2007 used 20 million CPU hours.

- Pre-render

  - Requires enormous processing resources and time for animated movies.

  - Computer carries out complex calculations to implement the object properties, lighting, camera angles and motions.

- Render in real time

  - Computer produces animation immediately.

  - Used in video games and highly interactive 3-D animations.

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ANIMATION TIPS & GUIDELINES

- Prepare for a learning curve.

  - Animation programs are more difficult to master.

- Design for delivery.

  - Minimize file size if delivery is for Web.

- Consider clip animation to reduce costs.

- Consult the tradition in developing motion.

  - Cycles, holds, shooting on twos, tweening, stretch and squash, ease in
    & ease out, overshoot & overlap motion are traditional techniques.

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