INTRODUCTION TO COMPUTER ANIMATION

OVERVIEW

- the "freedom and intuition" of the artist disdain the "logic and reason" of the computer

- stage actors disdained the cinema

- film actors disdained television

- computers have been used to create and animate drawings since the beginning of graphics

- annual art contest

- annual Siggraph competition

- contemporary uses

- painting (probably none hanging in major museums)

- sculpture

- architecture

- one recognized use - the animated film

- (1974) Foldes won the Prix du Jury at the Cannes Film Festival, interpolating between two drawings

- generally useful for filling in colors

- well-known animations

  - TRON (Disney)

  - Return of the Jedi (Lucasfilm)

  - Who Framed Roger Rabbit (Touchstone)

  - Aladdin (Disney)
OVERVIEW, cont.

- rapid growth in recent years
- regular conferences
- a leading theme in well-known journals
- several thousand films each year
- film festivals in several countries
OVERVIEW, cont.

- characteristics subject to change

  - for objects
    . location
    . orientation
    . size
    . shape
    . color
    . transparency

  - for cameras
    . viewpoint
    . interest point
    . view angle

  - for light sources
    . location
    . intensity

- our approach

  - basics of conventional animation

  - the role of the computer
CONVENTIONAL ANIMATION

Definitions

. "movement is the essence of animation"
  John Halas (1968)

. "art in movement"

. a technique in which the illusion of movement is created by photographing a series of individual drawings on successive frames of film. The illusion is produced by projecting the film.

. the process of dynamically generating a series of frames of a set of objects, in which each frame is an alteration of the previous frame

Exceptions

. video games (involving no photography)

. metamorphosis (one object is transformed into another)

. color changes (the hero turns red with emotion)

. changes in light intensity (as the sun disappears behind the mountains)
Making Cartoon Animated Films - Major Steps

1. the story
2. the layout
3. the sound track
4. the animation
5. in-betweening
6. xeroxing and inking
7. painting
8. checking
9. recording
10. editing
1. The Story (requires three successive documents)
   
   - the synopsis (a summary consisting of a few lines)
   
   - the scenario (a detailed description of the complete story without cinematographic references)
   
   - the storyboard (the film in outline form)
     
     - illustrations (with captions) in comic book fashion
     
     - sequences defining specific actions
     
     - a series of scenes making up a sequence
     
     - shots (picture units) making up a scene
2. The Layout
   . design of characters
   . action plotting
   . relationships between shapes and forms in the background and foreground

3. The Sound Track
   . precedes the animation
   . motion is made to match the dialog and/or music

4. The Animation
   . animators draw key frames
   . often an animator is responsible for a specific character

5. In-betweening (producing drawings between two key positions or frames)
   . assistant animators draw some in-betweens
   . in-betweeners draw the rest (almost an automatic task)
6. Xeroxing and Inking
   . pencil sketches
   . xerographic transfer to acetate cels
   . hand-inking of lines

7. Painting
   . cels
   . static backgrounds

8. Checking (of action in scenes before shooting)

9. Recording (of the composite animation on film or videotape)

10. Editing (part of the postproduction stage)
Multiplane and Shooting Phase

- machines called "multiplanes" simulate movement by moving cels relative to one another
  - several glass layers
  - a camera
  - perhaps 10' high
Some Techniques and Special Camera Effects

- **Pan** (contraction of panorama): the camera is rotated horizontally from one point to another
- **Track**: the camera is translated from one point to another
- **Tilt**: the camera is rotated vertically from one point to another
- **Zoom**: the camera is moved closer to or further away from the subject; a zoom lens provides the perspective effect which otherwise is lost
- **Spin**: the camera is rotated
- **Fade-in**: the scene gradually appears from black
- **Fade-out**: the scene gradually darkens to black
- **Cross-dissolve**: fading out of one scene and fading in to the next
- **Wipe**: a new scene appears to slide over the preceding scene
Uses of Optical Printers

- making positive and negative prints
- converting from one format to another
- modifying the speed of an action
- improving the quality of a film
- reprinting several cycles of a repeated motion
- superimposing titles and logos
- providing fade and wipe effects
Bar, Route, Model and Exposure Sheets

. Bar Sheets: a visual synopsis of the animation sequence
  - the number of frames per action
  - timing of dialog, mouth actions and music

. Route Sheets (for every scene):
  - length
  - location
  - responsible party
  - etc.

. Model Sheets: the original characters drawn in a number of representative poses

. Exposure Sheets (one line per frame, containing):
  - camera movements
  - zooms
  - number of exposures
Postproduction

- Processing: developing the film
- Editing
  - assembling
  - sorting
  - splicing
Historical Background

. (1831) animation invented by Joseph Antoine Plateau who developed the phenakistoscope (a spinning disk that held a series of drawings)

. (1834) Horner invented the zoetrope (a revolving drum with regularly spaced slits and drawings on its inner walls)

  - refined by Reynaud who developed the praxinoscope (slits were replaced by mirrors that spun in the center of the drum)

. (1892) Reynaud established the first movie theater in Paris

. (1906) J. Stewart Blackton produced the first animated film, Humorous Phases of a Funny Face

. (1909) Winsor McCay produced the first cartoon, Gertie the Trained Dinosaur (10,000 drawings)

. (1913-1917) various American cartoon series, such as Pat Sullivan’s Felix the Cat

. (1915) cel animation introduced by Earl Hurd, using transparent sheets of celluloid

. (1928-1938) Walt Disney, the father of commercial animation, produced Mickey Mouse, Donald Duck and the Silly Symphony Series
Historical Background, cont.

other participants

. Russia: Atamanov, Pashchenko and Ivanov
. Czechoslovakia: Trnka
. France: Bartosch
. Great Britain: John Halas
. Canada: Norman McLaren
Applications of Animation

- television
  - titles
  - logos
  - inserts
  - cartoons for children
  - commercials for the general audience

- cinema
  - complete films
  - special effects
  - titles
  - generics

- government
  - mass communication

- education and research
  - explanation of fundamental concepts for education
  - simulation for research

- industry
  - marketing
  - personnel education
  - public relations

- engineering
  - unambiguous identification of parts
  - quick production
Applications of Animation, cont.

- sample applications in engineering and science
  - motion of electromechanical devices (robots)
  - chemical reactions
  - fluid motion
  - cloud motions
  - heat conduction
  - flight simulation
  - crashes and explosions
COMPUTER ANIMATION

Roles for the Computer

. creation of drawings
  - digitizing key drawings
  - creating key drawings
  - producing complex objects procedurally

. creation of motion
  - in-betweening
  - producing complex motion procedurally

. coloring
  - fill (solid or patterned)
  - producing coloring procedurally

. shooting
  - computer control of the physical camera
  - procedural control of the virtual camera

. postproduction
  - computer-assisted editing
  - computer-controlled synchronization
Classification of Animation Systems (by Levels)

- interactive creation, painting, storing, retrieval and modification
drawings
  - time is not considered
  - a mere graphics editor

- computing of in-betweens and movement of an object along a
trajectory
  - time is considered
  - used by or replaces in-betweeners

- operations
  - translation
  - rotation
  - maybe zoom, pan, track, and tilt

- definition of actors (objects possessing their own animation and
perhaps constraints)

- intelligent
  - extensible
  - learns as it works
  - not yet available
Classification of Animation Systems (computer-assisted vs. modeled)

- computer-assisted (key-frame) animation
  - assisting conventional animation by computer

- modeled animation
  - 3D drawing and manipulation of more general representations
  - very difficult without a computer

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Classification of Animation Systems (real-time vs. frame-by-frame)

. interactive (TETRIS) or passive (Tin Toy)

. at least 15 frames must be presented each second

- only relatively simple calculations can be made in real time
- refraction, texture and shadows cannot yet be done in real time

. resolution, color, shading, transparency, shadows, etc. require

- speed
- storage
- sufficient instruction sets
- graphics processing capability

. array processors
. graphics professors
Frame Buffer Animation and Real-time Playback

- bits can be interpreted differently without changing the contents of the frame buffer, causing the illusion of animation
  - modification can be cyclic, alternated or selective
- zoom, track and scroll can be used to view the contents of (different regions of) the frame buffer
- crossbar animation routes any of the bits from the frame buffer to any of the input lines in look-up tables
- frames can be
  - compiled in advance
  - saved in mass storage
  - played back in real time