Computer Graphics and Animation
1-History

Prof. Dr. Charles A. Wüthrich,
Fakultät Medien, Medieninformatik
Bauhaus-Universität Weimar
caw AT medien.uni-weimar.de
History (CG)

- Strong interconnection of the histories of
  - Computer Graphics
  - Interactive Computer Games
  - Computer Animation
- Like many other modern development, Computer Graphics has its roots in hardware development for military applications

MIT Whirlwind (1950)
History (CG)

- Strong interconnection of the histories of
  - Computer Graphics
  - Interactive Computer Games
  - Computer Animation
- Like many other modern development, Computer Graphics has its roots in hardware development for military applications
- What is so interesting in this bulky object?

MIT Whirlwind (1950)
History (CG)

• Strong interconnection of the histories of
  – Computer Graphics
  – Interactive Computer Games
  – Computer Animation

• Like many other modern development, Computer Graphics has its roots in hardware development for military applications

• What is so interesting in this bulky object?

MIT Whirlwind (1950)
History (CG)

• And what is interesting in this?

SAGE (1955)
History (CG)

- And what is interesting in this?

SAGE (1955)
History (CG)

- First games developed end of the ‘50s

“Tennis for two” on the Whirlwind (Higinbotham 1958)

SpaceWar (DEC PDP-1): 2 users/joystick (Russell 1962)
History (CG)

- Interactive drawing (CAD)

“Sketchpad” MIT (Sutherland 1963)
History (CG)

- PCs came to life

Apple II, Commodore PET
History (CG)

- They made Computer Graphics affordable
- Before PCs, graphics workstations cost hundreds of thousands
  - Evans&Sutherland
  - Apollo
  - Silicon Graphics (SGI)
- Today, fast graphics cards allow real time parallel processing
- Rendering is done on rendering farms: networked PCs
History (CG)

- Algorithms and Methods for Computer Graphics (60-80)

Modeling:
Polygons, Curves, Surfaces

Illumination:
Light, Colour, Surface-Light interaction
History (CG)

- In the 60s and early 70s, light reflection properties were modeled for their use in computers
  - Shading algorithms
    - Flat shading
    - Phong shading
History (CG)

- At the same time, special curves were developed for their use in Computer Graphics: splines
  - Bezier curves
  - B-splines
  - NURBs
  - T-splines
History (CG)

• Complex modeling programs were developed in the 80s
• Allowing more and more realistic renderings
  – Raytracing
  – Radiosity
History (CG)

- Nowadays there is a whole set of options for doing graphics on computers
- All one needs:
  - A fast PC
  - For complex renderings a cluster of PCs
  ...and of course some good software

- Every designer knows:
  - 3D Max
  - Maya
  - ... all possible variations of software

  - Most of them very expensive

- We don’t have much money, so we will use Open Software:
  - Blender

---

![Blender Logo](blender.png)
Computer Graphics and Animation
2-Animation history

Prof. Dr. Charles A. Wüthrich,
Fakultät Medien, Medieninformatik
Bauhaus-Universität Weimar
caw AT medien.uni-weimar.de
Early animation devices

- First experiments with persistence of vision done early 1800
- Animation existed before the camera
- Perhaps simplest device: thaumatrope
  - Flipping circle with two drawings
Early animation devices

• Flipbook
  – Very common, and survived till today
• Motion through page flipping
Early animation devices

• Zoetrope: wheel of light
• Cylinder
  – Inside: drawings
  – Slits cut between frames on cylinder
  – Allow viewer to see only one frame
  – Illusion of movement
Early animation devices

- Phenakistoscope: greek for "spindle viewer"
- Two disks rotating in sync (or one at the mirror)
  - Back side: drawings
  - Slits cut between frames on cylinder
  - User can see only one small part of frame at a time
  - Illusion of movement
Early animation devices

- Praxinoscope: greek for „who knows?“
- Here rotating mirrors are used for allowing only the view on one frame at the back of the external cylinder
“Conventional” animation

- Filming of two-dimensional handdrawings
- Georges Méliès (1896) used camera tricks (multiple camera exposures, stop motion) to make objects appear, disappear and change shape.
- Emile Cohl produced several vignettes
- J. Stuart Blackton animated smoke on a movie (1900) and created first animated cartoon in 1906.
„Conventional“ animation

• Windsor Mc Cay, a newspaper cartoonist, produced first animated cartoons
  – Little Nemo (1911)
  – Gertie the dinosaur (1914).

• Technique used:
  – Draw each image on rice paper
  – Film them individually

• In many of his works, he interacted live with his characters
„Conventional“ animation

- John Bray started 1910 to work at patenting the animation processes.
- Was joined in 1914 by Earl Hurd, who patented the use of translucent *cels* to compositing multilayered images.
- Bray patented also:
  - The use of grayscale
  - He then enhanced overlaying to include a peg system for registration of the layers
  - Finally he patented drawing on long sheets to allow panning on the background
„Conventional“ animation

- Out of Bray’s studio came following authors:
  - Max Fleischer (*Betty Boop*)
  - Paul Terry (*Terrytoons*)
  - George Stallings (*Tom and Jerry*)
  - Walter Lanz (*Woody Woodpecker*)
„Conventional“ animation

• In 1915 Fleischer patented rotoscoping: draw images on cells by tracing previously recorded live actions
• Bray did experiment also with colour (1920) in the short „The debut of Thomas Cat“
„Conventional“ animation: arts?

- Technology developed fast
- However, the artistic side struggled for long
- First complete character with personality:
  - *Felix the Cat* (Otto Messmer) very successful in mid 1920s
Walt Disney

- Walt Disney was the most successful conventional animator
- First to use storyboards for animations
- In 1928, he was the first to add sound to animations in „Steamboat Willie“
Walt Disney

- Major technical innovation of Walt Disney:
  - Multiplane camera
  - Camera mounted on top
  - Each plane holds an animation cell
  - Planes move along 3 axes
- Allows parallax motion (multiplane backgrounds)
Walt Disney: arts

• Disney preferred to give characters a long lasting personalities
• Focus on character, build stories around it
• Major characters: Mickey Mouse, Pluto, Goofy, Donald Duck
• Studied intensively real life motion
• Developed first „mood pieces“
  – Skeleton Dance in 1929
  – Fantasia in 1940
Animation studios

• The success of Walt Disney pushed others to initiate animation studios
Alternative techniques

- Stop motion techniques have been also very popular:
  - Clay animation
  - Puppet animation
- Here figures are moved one frame at a time, and snapshots are taken.
- Father of these techniques: Willis O’Brien (King Kong)
- Ray Harryhausen (Mighty Joe Young)
- In Europe: Fusako Yusaki (Fernet Branca)
What about 3D?

- First movie to make extensive use of animation?
Computer Animation: examples

• First movie to make extensive use of animation?
• Tron, Disney, 1982
Computer Animation: examples

- Geri’s Game: Copyright Pixar (1999)
- For the Birds: Copyright Pixar (2001)
Traditional animation: production

- **Production** indicates the whole film
- Productions are split in **sequences**: each sequence is usually identified by an associated staging area. There are 1 to 12 sequences in a production
- A sequence is broken in one or more **shots**. Each shot is a continuous camera recording
- A shot is broken down into individual **frames**. A frame is a single image

<table>
<thead>
<tr>
<th>Production</th>
<th>Sequence 1</th>
<th>Sequence 2</th>
<th>Sequence 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shot 1</td>
<td>Shot 2</td>
<td>Shot 1</td>
<td>Shot 1</td>
</tr>
<tr>
<td>Shot 2</td>
<td>Shot 2</td>
<td>Shot 2</td>
<td>Shot 3</td>
</tr>
<tr>
<td>.</td>
<td></td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Frames</td>
<td>1</td>
<td>2</td>
<td>n</td>
</tr>
</tbody>
</table>

---

Bauhaus-Universität Weimar
Faculty of Media
Traditional animation: production steps

- First a *preliminary story* is decided
- This includes a *script*
- A *storyboard* is developed: it lays out action scenes by sketching representative frames and writing text to it
  - A storyboard is used for discussing action
- For each character, *model sheets* are done. They are drawings of the character in different poses for keeping the characters consistency across animation
- The *exposure sheet* records all info of each frame (camera moves, sound cues, composing elements)
- The *route sheet* records stats and responsibility for each scene
- A *story reel* may be produced: a recording of the keyframes, each for as long as the scene it represents. It helps reviewing the timing of movie
Traditional animation: production steps

- Once storyboard is decided, work on the detailed story is done (detail in action)
- *Keyframes* (or *extremes*) are identified and drawn by master animators
- Assistant animators draw the inbetweens between the keys (*inbetweening*)
- Test shots are done on short sequences to check rendering and movement
- Sometimes movement can be checked on pencil drawings
- Once sequence is fixed
  - *Inking* is done (transferring contours to the cels)
  - *Opaquing* is done (filling with colour)
Traditional animation: sound

- Sound is extremely important in animation
- Contrary to regular movies, precise timing is possible
- Depending on importance of sound, either
  - Animation is done first: here a *scratch track* (or rough sound track) can be built while storyboard is developed
  - Sound track is done first e.g. for lipsyncing
And in Computer Animation?

- Many of the tasks and tools before are used here too: storyboarding, model sheets, keyframing....
- However, computer animation allows more flexibility
- Moreover, animators can turn on/off effects to concentrate on partial aspects
- They can even simplify rendering to check for particular aspects
- Moreover, even at rendering time certain aspects can be turned on/off to speed up the process e.g. Which objects cast shadows to where
Producing a Computer Animation

- **Story Dept**: Converts screenplay to storyboard and to story reel
- **Art Dept**: Creates design and color studies, including detailed model description and lighting scenarios
- **Modeling Dept**: Creates the characters and the world they live. Often parametrizes figures to control movement of figures
- **Layout Dept**: Implements staging and blocking. Is responsible for taking the film from 2D to 3D
- **Shading dept**: Adds textures, displacement shaders and lighting models
- **Animation dept**: Responsible for character „life“. Produce gestures and subtle animation detail
- **Lighting dept**: Assigns teams to each sequence so that lighting is done as the arts department wishes
- **Camera dept**: renders the frames
Editing

- Once images are produced, they have to be assembled into the final movie.
- Originally, sequences got mixed one after the other linearly in time (the output was linear).
- Later, timestamps were added so that some non-linear editing was possible.
- Nowadays, almost every PC is capable of non-linear editing.
- Here, tracks can be mixed, inserted, overlayed, sound can be added to them at will.
History: early days (60s-70s)

- It all started from Ivan Sutherland’s interactive machine (MIT 63)
- First animated computer sequence: Ed Jazzac (Bell Labs)
- Early 70s: Univ. of Utah established program of CG (Catmull)
- Early Labs (late 70s):
  - U. Pennsylvania (N. Badler)
  - NYIT (Catmull)
  - Ohio State (De Fanti, Csuri)
  - U. Montreal (D. And N. Thalmann)
- Animation mostly in Labs
History: towards maturity (80s)

• Three major events:
  – Development of graphics capable hardware (SGI) and rendering
  – Development of complex algorithms for modeling
  – Appearance of first animation studios and first complex films
• First animated computer film: Tron (Disney 1982)

• Big animation studios at that time:
  – Digital Pictures
  – Image West
  – Cranston-Csuri
  – Pacific Data Film
  – Lucasfilm (who became Pixar)

• First animation Oscars won: Tin Toy (1988)
History: maturity(?) (90s-today)

• Major productions of
  – Complex special effects
  – Whole productions
  – Digital characters in movies
• Two real big players:
  – Pixar (Star Trek II, Toy Story, Monsters......)
  – ILM (Terminator II, The Abyss, Casper, Jurassic Park, ....)
• Animation big in commercials
  – Here smaller studios work

• Software available nowadays off the shelf
• Hardware too (despite Pixar ‘s Renderfarms)
• Modeling possible at home
History: maturity(?) (90s-today)

• 3D movies: Avatar.

Courtesy 20th Century Fox © 2009
End

+++ Ende - The end - Finis - Fin - Fine +++ Ende - The end - Finis - Fin - Fine +++

Copyright (c) 1988 ILM
Thank you!

- Web pages
  http://www.uni-weimar.de/medien/cg