
Computer Graphics and Animation

1-History

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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



Courtesy © wired.com

MIT Whirlwind (1950)

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- What is so interesting in this bulky object?

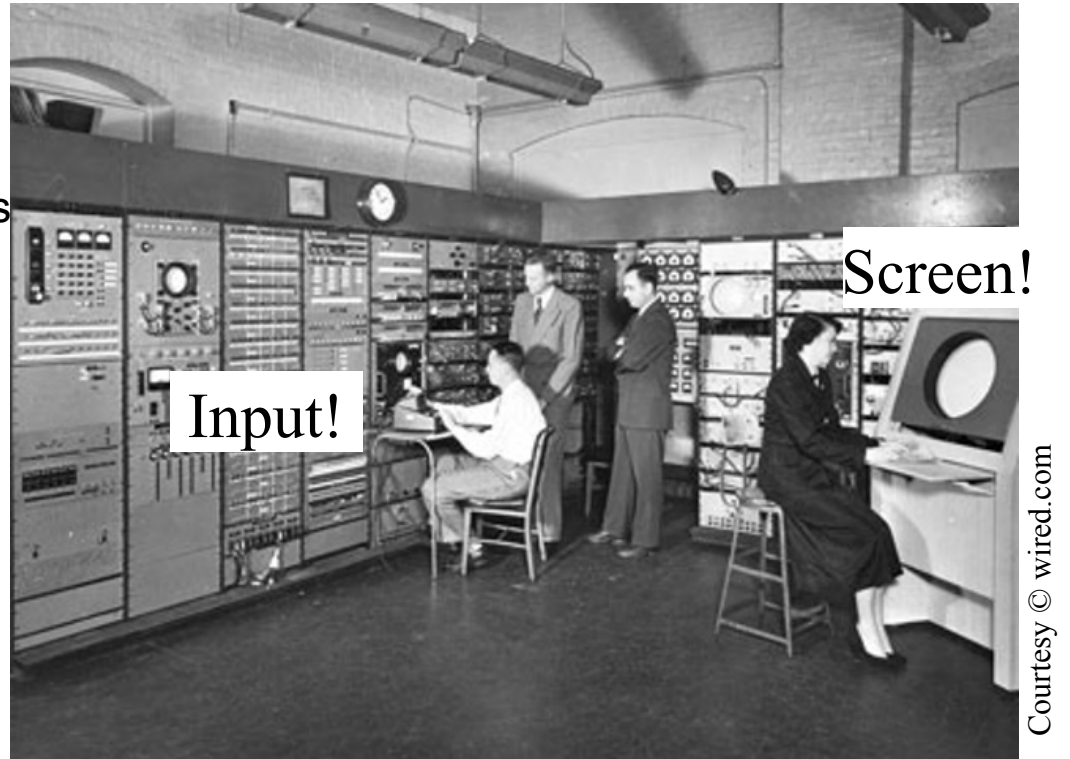


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History (CG)

- And what is interesting in this?

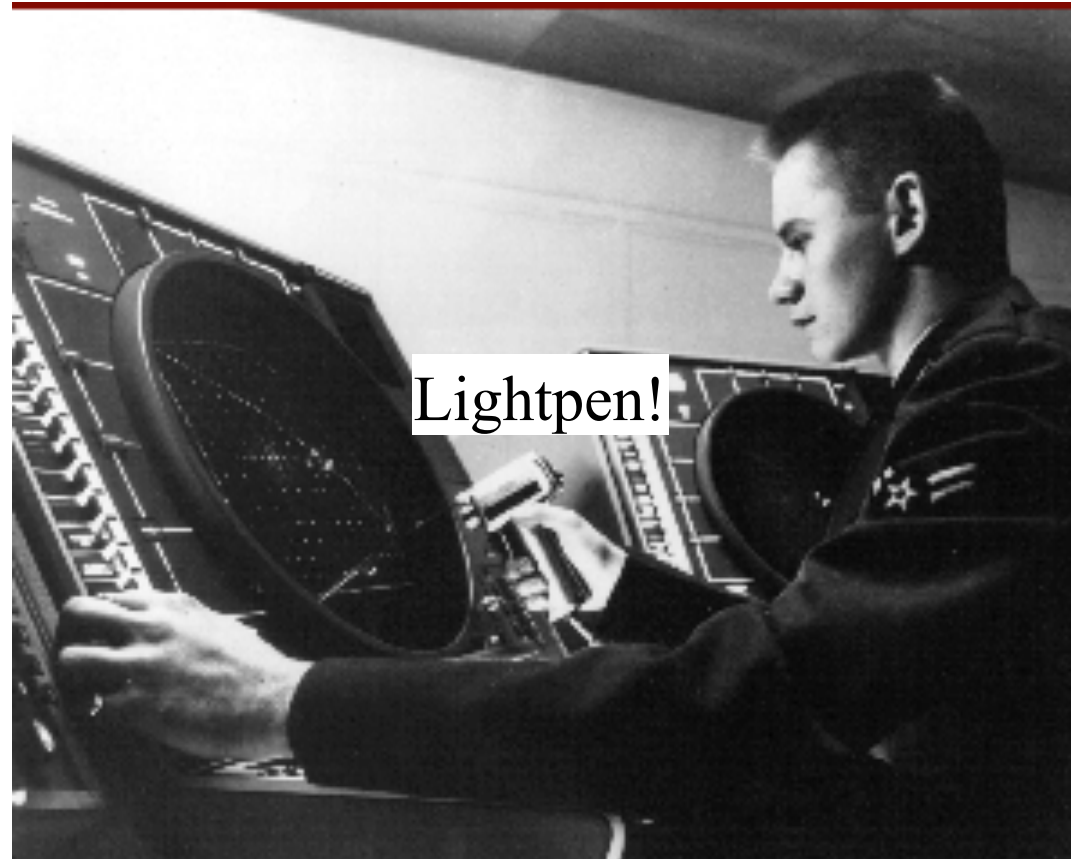


Courtesy © IBM online archive

SAGE (1955)

History (CG)

- And what is interesting in this?

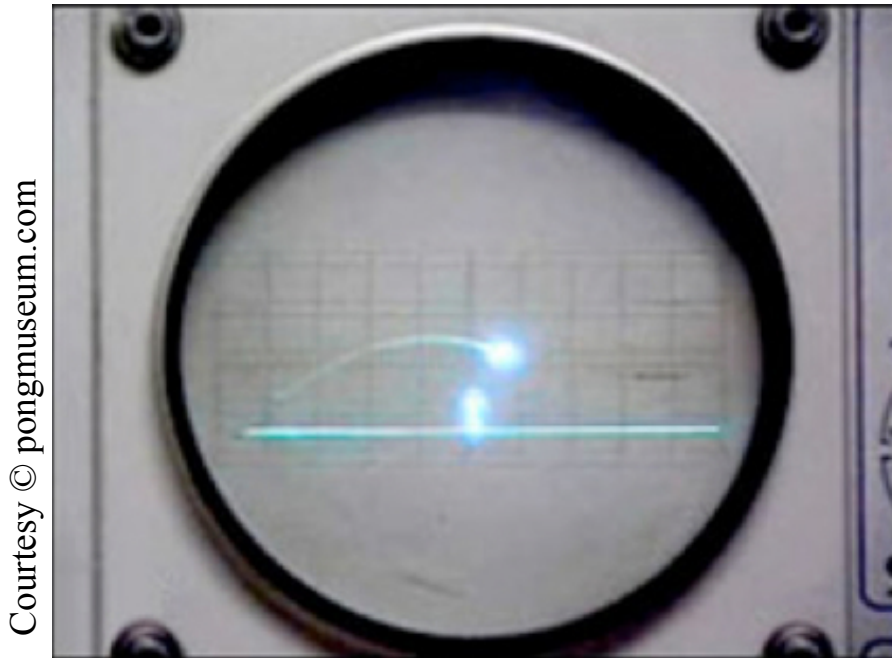


Courtesy © IBM online archive

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

Courtesy © Apple



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



Courtesy © Apple



History (CG)

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

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CNR, Pisa



Modeling:
Polygons, Curves, Surfaces

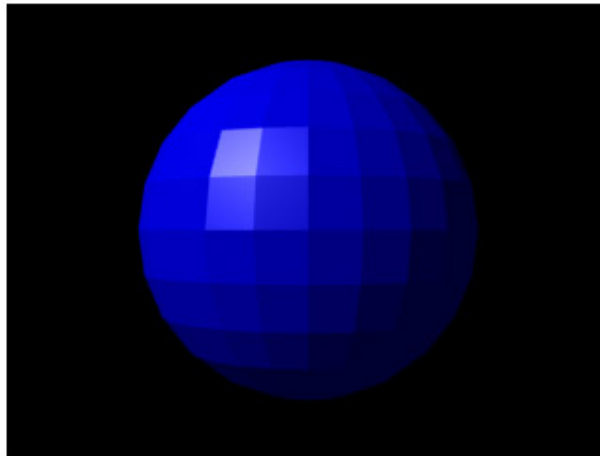


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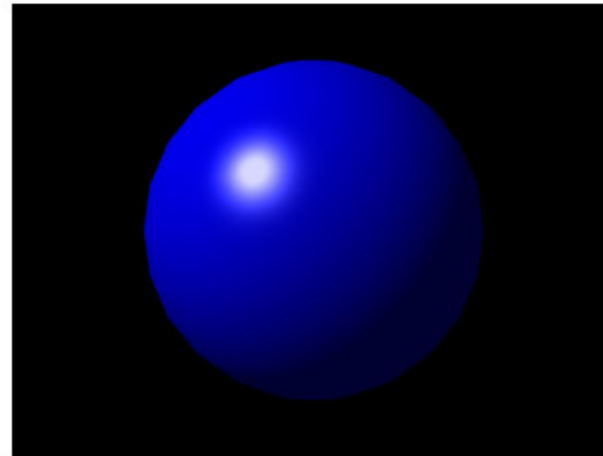
Illumination:
Light, Colour, Surface-
Light interaction

History (CG)

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



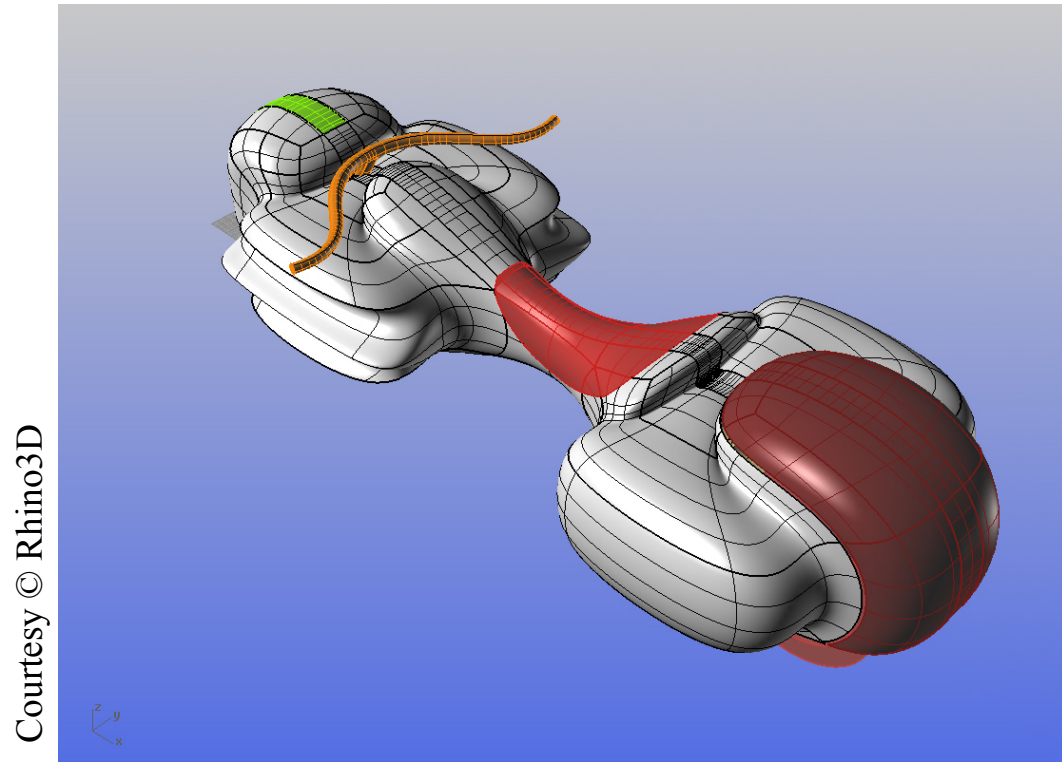
FLAT SHADING



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



Copyright 1991 Eric Haines,
The Hewlett-Packard Company



Courtesy Martin Moeck, Siemens Lighting, 1994

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



Computer Graphics and Animation

2-Animation history

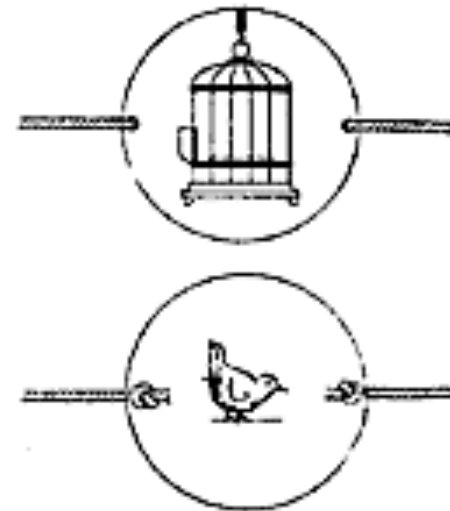
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Early animation devices

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



THAUMATROPE,
1825



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



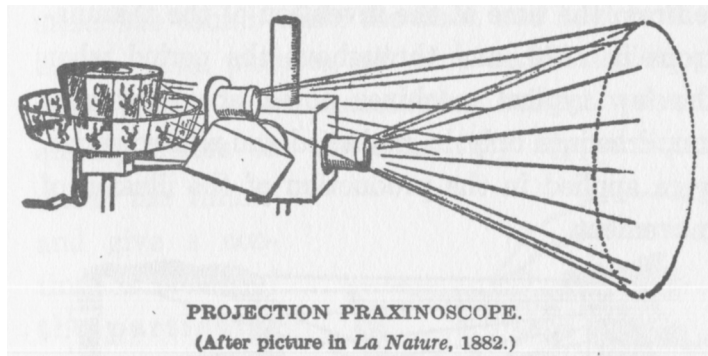
Early animation devices

- 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 cam 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 *ce/s* 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 Lantz (*Woody Woodpecker*)

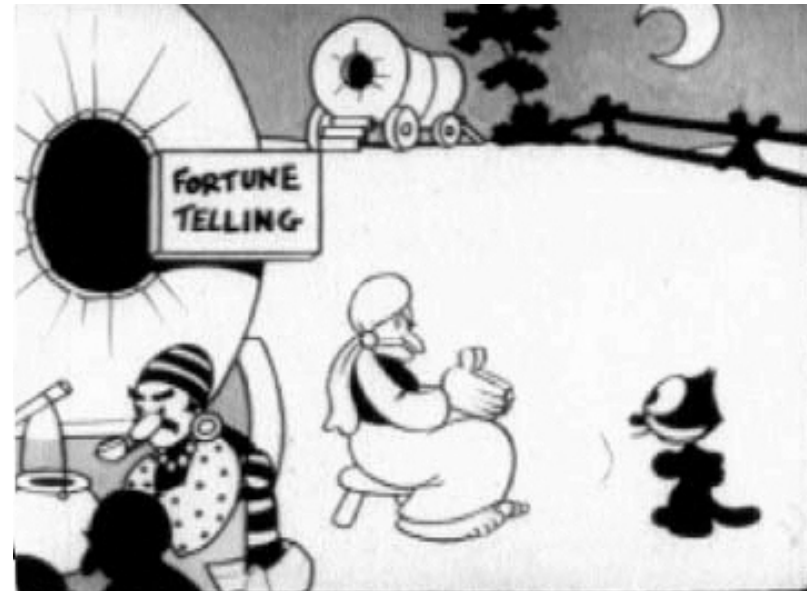


„Conventional“ animation

- 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?

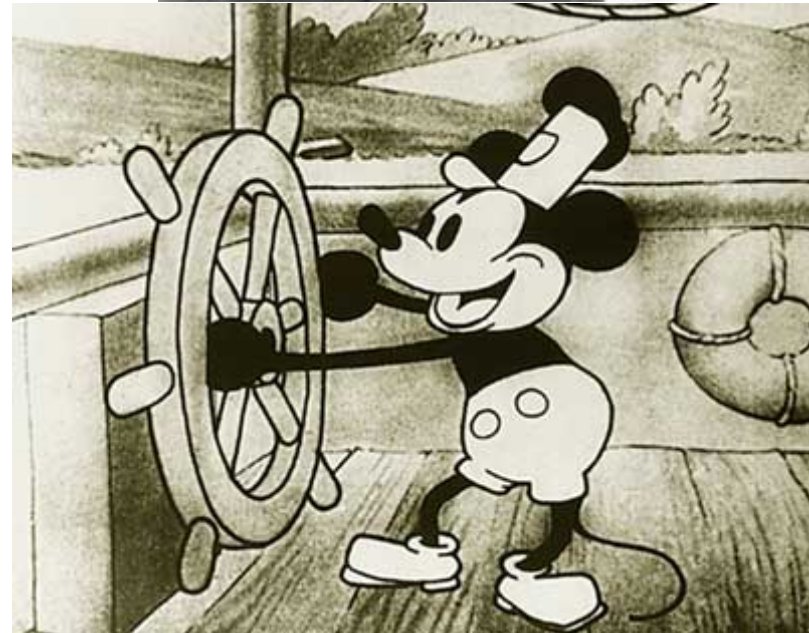
- Technology developed fast
- However, the artistic side struggled for long
- First complete character with personality:
 - *Felix the Cat* (Otto Messmer) very successful in mid 1920s



Copyright (c) 1926 Pat Sullivan Studio

Walt Disney

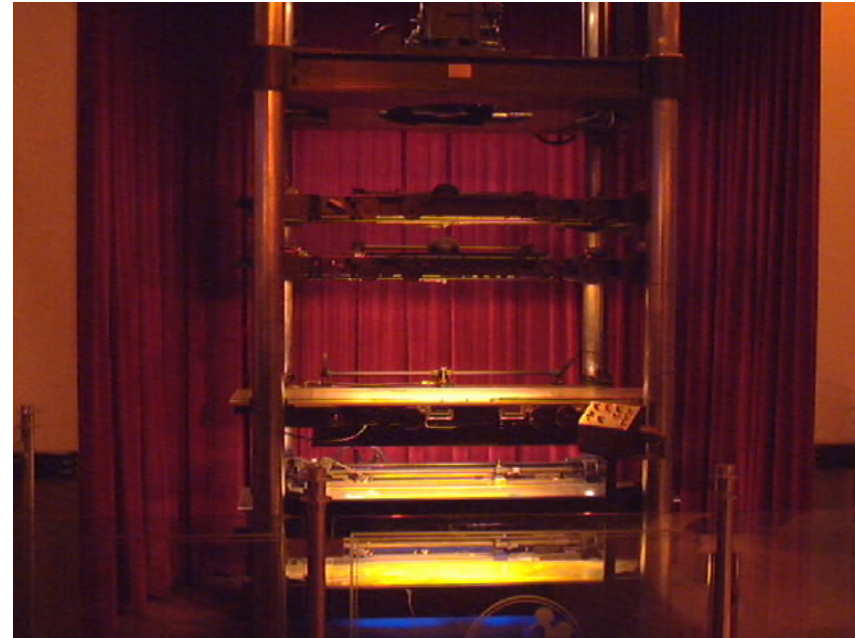
- Walt Disney was the most successful conventional animator
- First to use storyboards for animations
- In 1928, he was the first to add sound to animations in „Steamboat Willie“



Copyright (c) 1928 Walt Disney Productions

Walt Disney

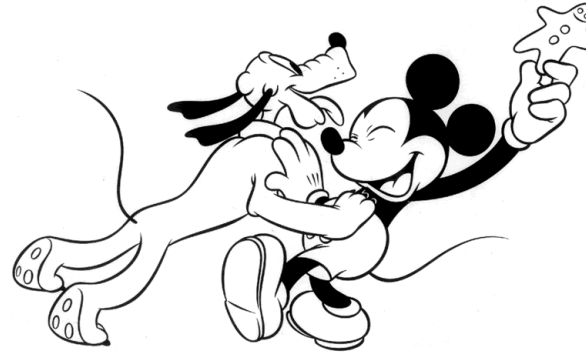
- Major technical innovation of Walt Disney:
 - Multiplane camera
 - Camera mounted on top
 - Each plane holds an animation cell
 - Planes move along 3 axes
- Allows parallax motion (multiplane backgrounds)



Courtesy Sébastien Barthe

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



© Walt Disney Productions

Copyright (c) Walt Disney Productions

Animation studios

- The success of Walt Disney pushed others to initiate animation studios
- Well known animation studios: Fleischer, Iwerks, Van Beuren, Universal Pictures, Paramount, MGM, Warner Brothers.

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 'Brian (*King Kong*)
- Ray Harryhausen (*Mighty Joe Young*)
- In Europe: Fusako Yusaki (Fernet Branca)



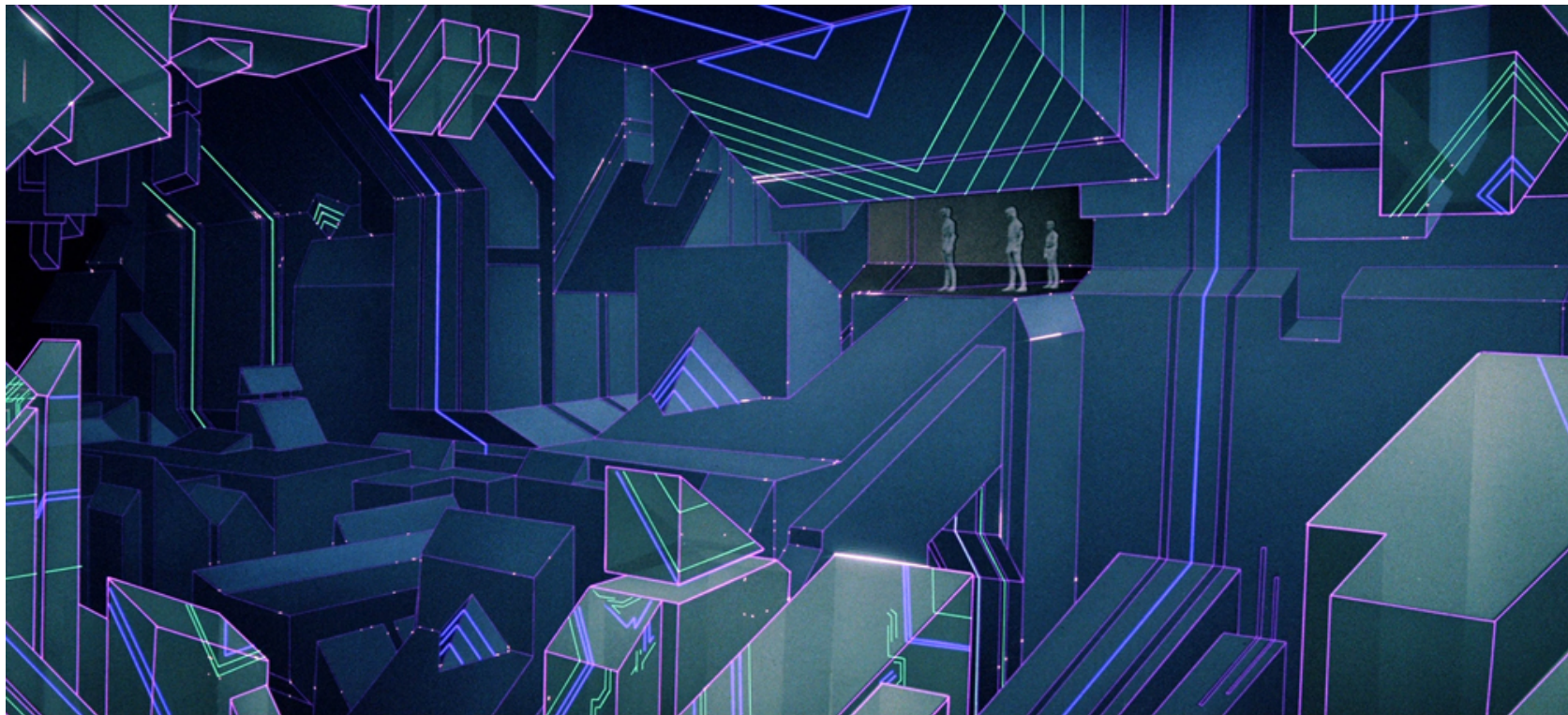
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What about 3D?

- 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

- Finding Nemo: Copyright Pixar (2003)



- 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

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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)

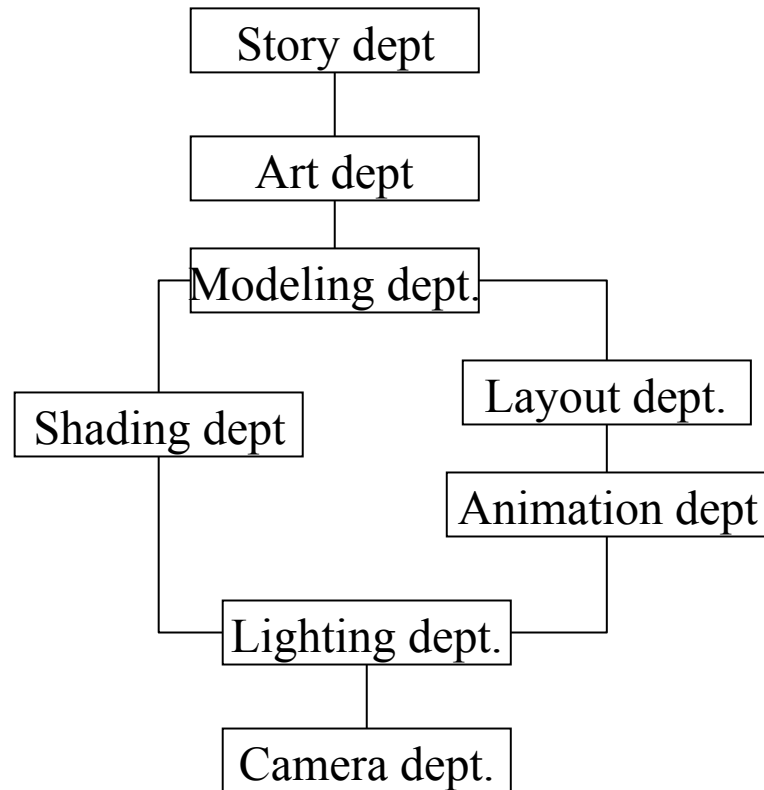
Traditional animation: sound

- 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



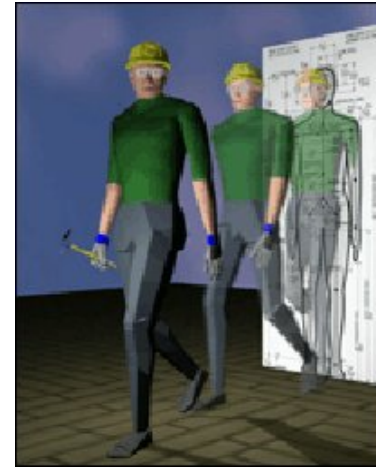
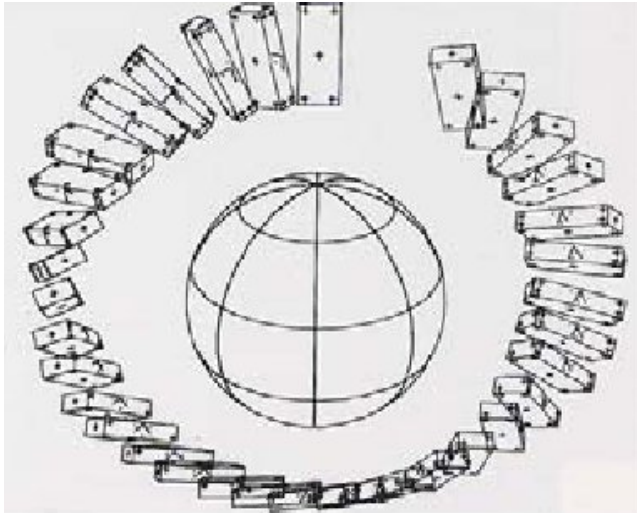
- **Story Dept:** Converts screenplay to storyboard and to story reel
- **Art Dept:** Creates design and color studies, including detailed model description and lighting scenarios
- **Modeling Dept:** Creates the characters and the world they live. Often parametrizes figures to control movement of figures
- **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



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Thank you!

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