

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

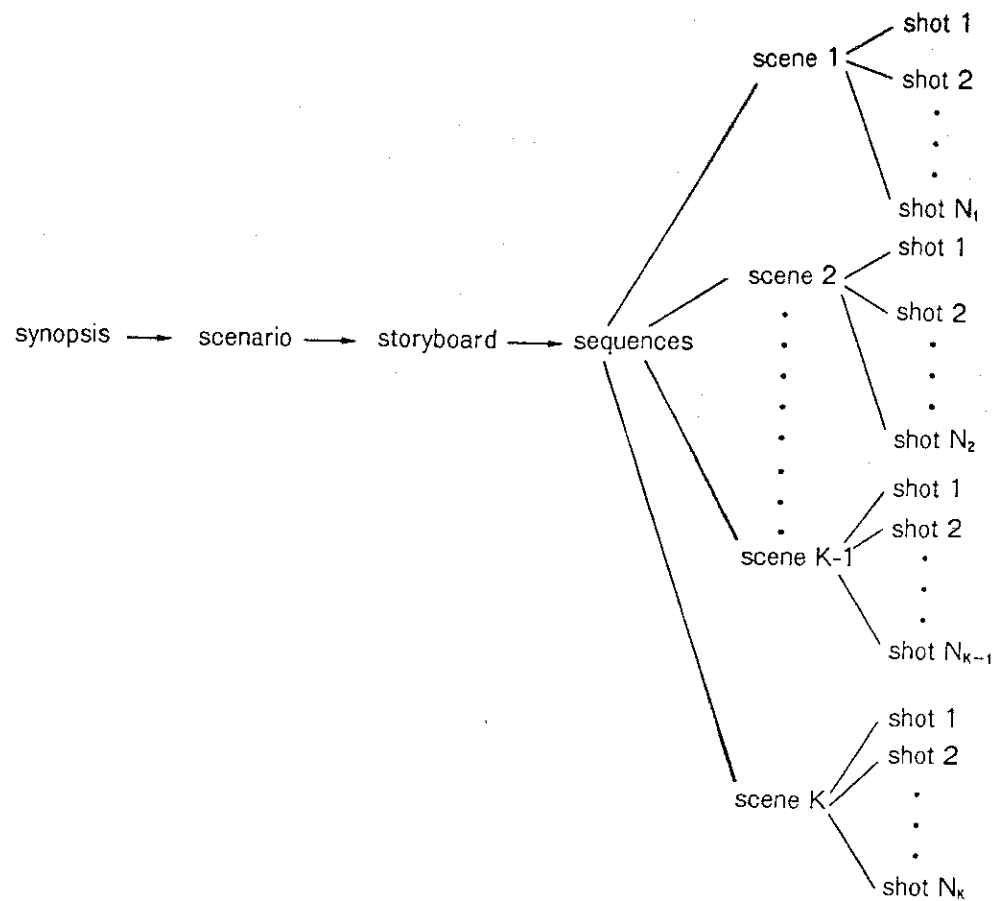
- . **video games (involving no photography)**
- . **metamorphosis (one object is transformed into another)**
- . **color changes (the hero turns red with emotion)**
- . **changes in light intensity (as the sun disappears behind the mountains)**

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**

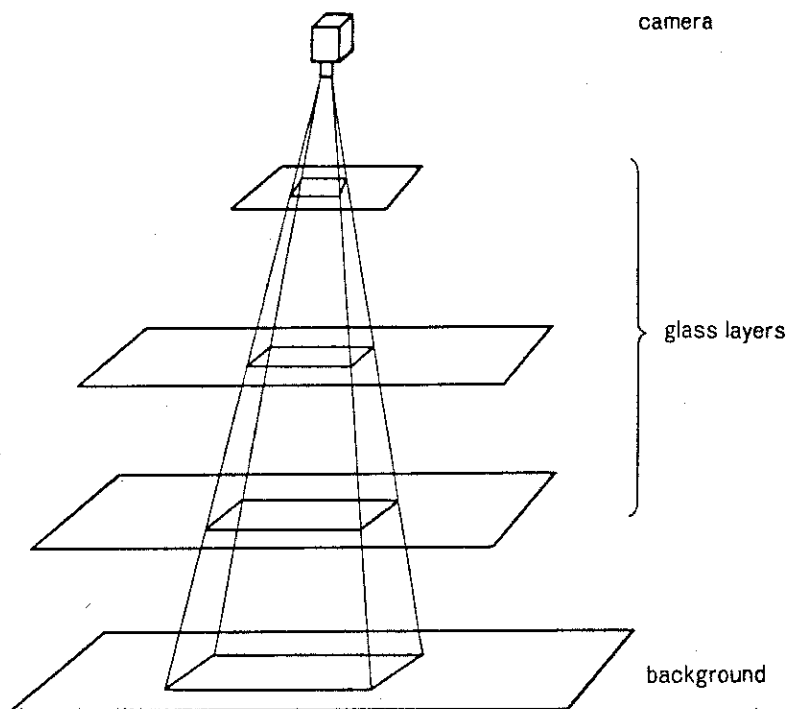
8. Checking (of action in scenes before shooting)

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

10. Editing (part of the postproduction stage)

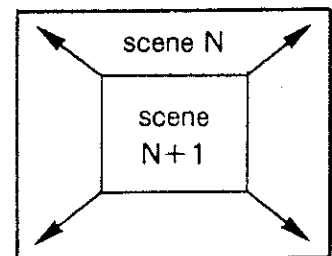
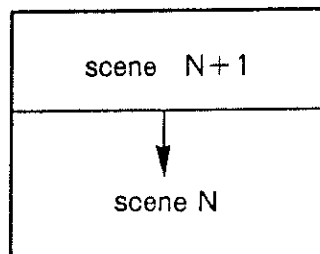
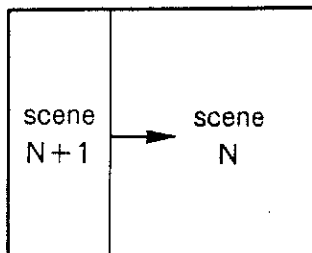
Multiplane and Shooting Phase

- machines called "multiplanes" simulate movement by moving cels relative to one another
 - several glass layers
 - a camera
 - perhaps 10' high



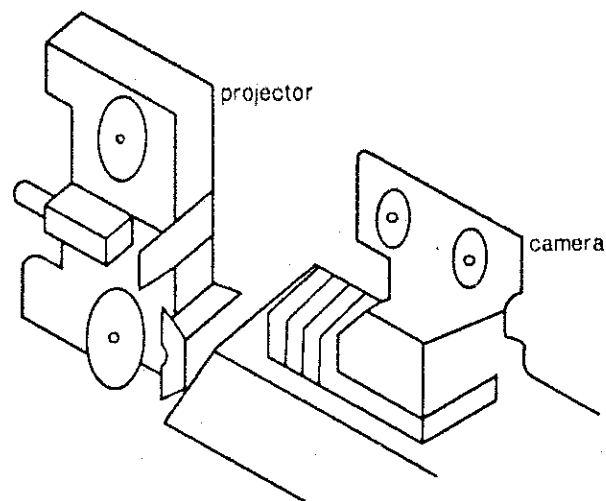
Some Techniques and Special Camera Effects

- . **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**

	Computer-assisted animation	Modelled animation
Object creation	<ul style="list-style-type: none">- character digitizing- use of a graphics editor	<ul style="list-style-type: none">- 3D reconstruction programs- 3D graphics editor- 3D object modelling programs
Motion	<ul style="list-style-type: none">- in-between calculation- movement along a path	<ul style="list-style-type: none">- 3D motion programming- actor systems
Coloring	<ul style="list-style-type: none">- painting systems	<ul style="list-style-type: none">- 3D shading systems
Camera	<ul style="list-style-type: none">- physical camera control	<ul style="list-style-type: none">- virtual cameras
Postproduction	<ul style="list-style-type: none">- editing systems- computer-assisted synchronization	<ul style="list-style-type: none">- in theory, modelled systems could eliminate the postproduction phase by updating films automatically

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 processors**

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**