

SCENE DYNAMICS

ANIMATION, SKELETON, TIMELINE

TOMÁŠ POLÁŠEK IPOLASEK@FIT.VUT.CZ

BRNO UNIVERSITY OF TECHNOLOGY

FACULTY OF INFORMATION TECHNOLOGY

DCGM, CPhoto@FIT

FACULTY OF FINE ARTS

GAME MEDIA STUDIO

9



MAKING THINGS MOVE

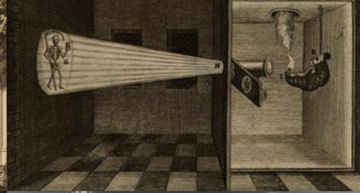
EVOLUTION OF ANIMATION

- Illusion of Movement
- Historical Development
- World in 2D & 3D
- Animation in Games
- → Animation System



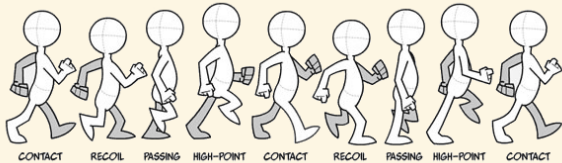
HUMBLE BEGINNINGS

- [1604] Camera Obscura
- [1659] Laterna Magica
- [1866] Zoetrope
- [1906] Humorous Faces
- [1928] Steamboat Willie
- [1937] Snow White

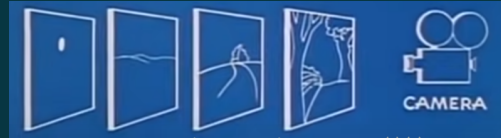


TRADITIONAL ANIMATION

- Sequence of Frames
- Cel Animation
- Depth & Parallax
- Frame Rate: Full × Limited
- On “Ones” and “Twos”
- Animation Loops
- → CGI



Source: Angry Animator



Source: Walt Disney's MultiPlane Camera (1) (2)

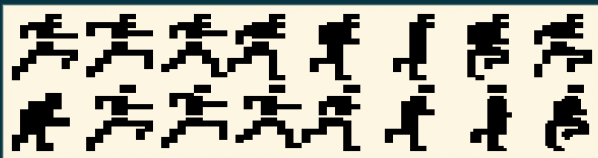


Source: Brandon Kouri: Snow White Cel Animation

ANIMATION IN GAMES

SPRITE GRAPHICS

- Sprite $\approx$ Bitmap
- Limited Resources
- Retro & Pixel Art
- Simple Authoring
- Sprite Sheet



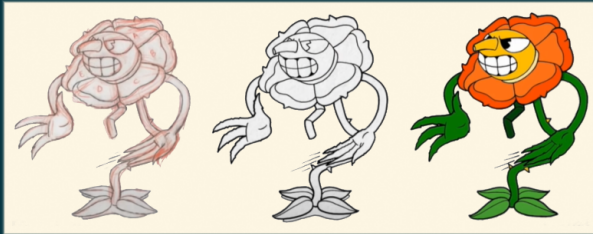
Source: Intellivision Running Man



Source: Nintendo's Super Mario World

SPRITE ANIMATION

- Cels $\rightsquigarrow$ Sprites
- Composition & Playback
- Palette Cycling
- Rotoscoping (“Tracing”)
- Digitized Animation



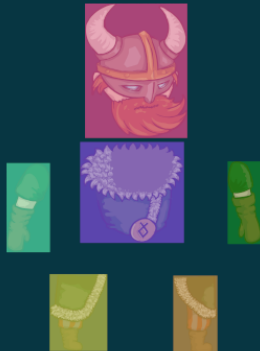
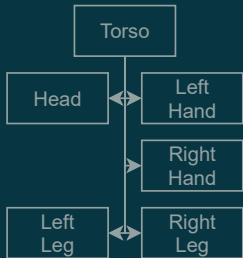
Source: Cuphead – The animation process



Source: Doom

RIGID ANIMATION

- Time Consuming → Automation
- Decompose the Model
- Part Hierarchy
- Animate Parts
- Rigid & Cracking
- Both 2D & 3D



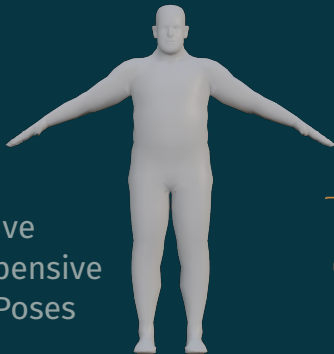
MOVING VERTICES

- Granularity → Fluidity
- Per-Vertex Animation
 - Complete Control
 - Model per Frame
 - Memory Intensive
- Morph Target Animation
 - Blending Poses
 - Model Semantics
 - Limited Memory



ANIMATION AS COMPRESSION

- Limited Resources
 - Time is Money
 - Ease of Use
 - Semantic Manipulation
-
- Full $\rightsquigarrow$ Difficult & Time Intensive
 - Vertex $\rightsquigarrow$ Computationally Expensive
 - Morph $\rightsquigarrow$ Fitting Task, Needs Poses
-
- $\Rightarrow$ Skinned Skeletal Animation



Source: Andy Goralczyk: Vincent

THE SKELETON

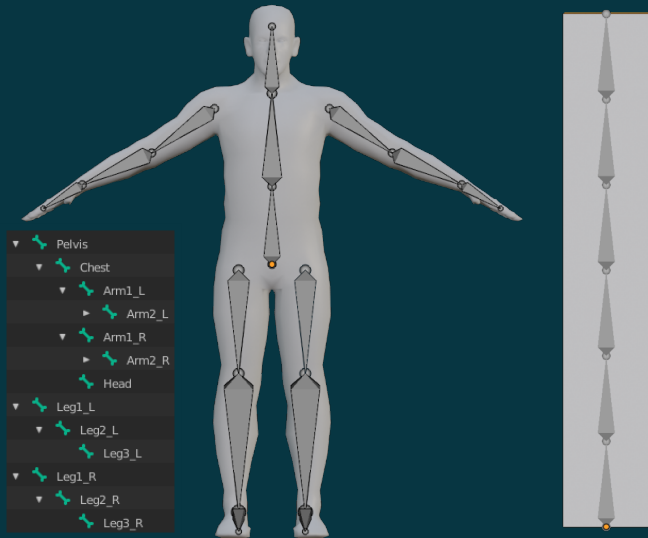
- Bones & Joints
- Skeletal Hierarchy

- Joint Properties
 - ▶ Identifier
 - ▶ Transformation
 - ▶ Parent

- Bone Properties
 - ▶ Position
 - ▶ Length & Scale
 - ▶ Rotation

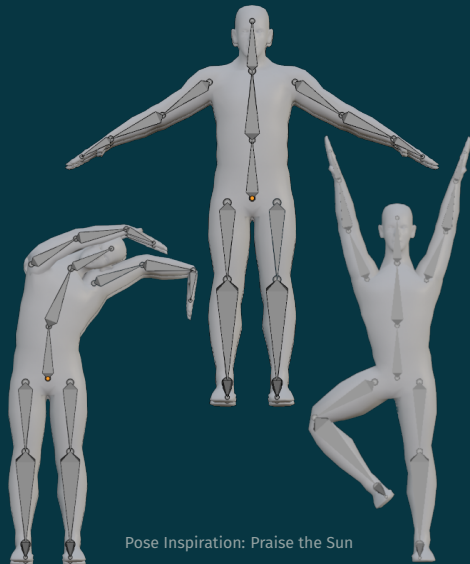
- Root Bone

- Rigging



POSING THE MODELS

- Skeleton Poses
- Bind Pose
 - Neutral Position
 - Easier Rigging
- Composition
- Posing Joints
 - Local
 - Global



Pose Inspiration: Praise the Sun

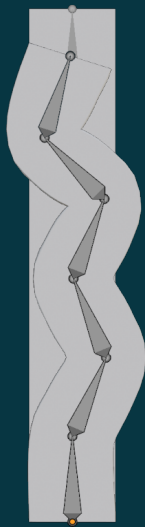
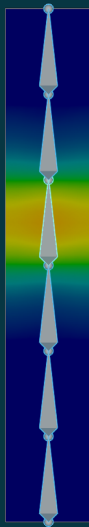
ANIMATION CLIPS

- Granularity → Clips
- Timeline
 - Local – Looping
 - Global – Continuous
- Synchronization
- Pose Interpolation
- Animation Blending
- Animation Parameters
- Retargeting Clips



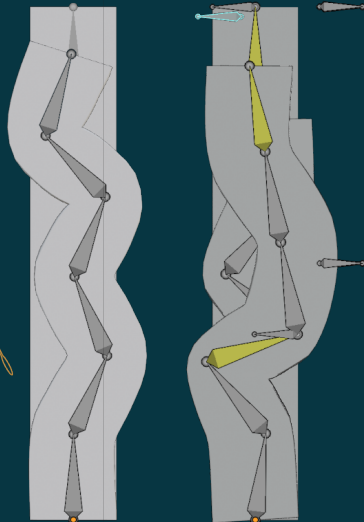
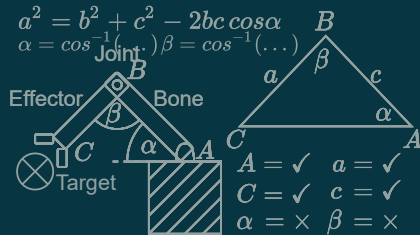
SKINNED ANIMATION

- Bones ↔ Mesh
- Vertex Skinning Data
 - Bone Identifier/s
 - Weight/s
- Delta Transformation
- “Painting” Vertices
 - Manual
 - Automated



FORWARD AND INVERSE KINEMATICS

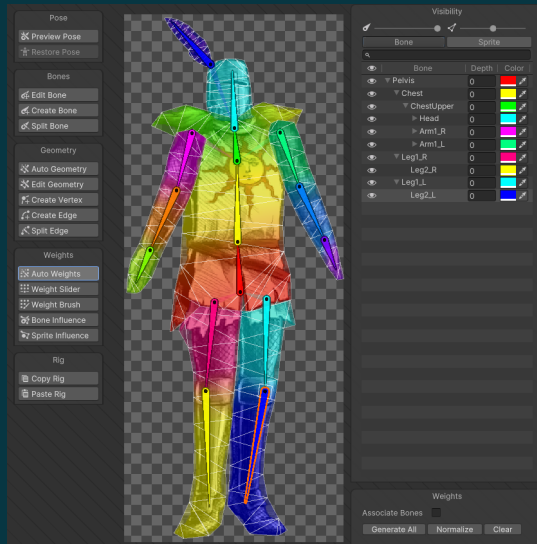
- Explicit → Forward
- Implicit → Inverse [1]
- Effector & Target
- Minimize Error
- → Solver



ANIMATION IN UNITY

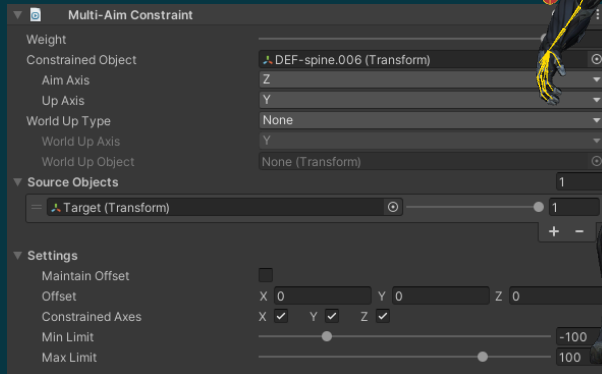
2D ANIMATION

- Sprite & Skeleton
- Asset Import
- Sprite Sheets
- Sprite Editor
- Rigging & IK



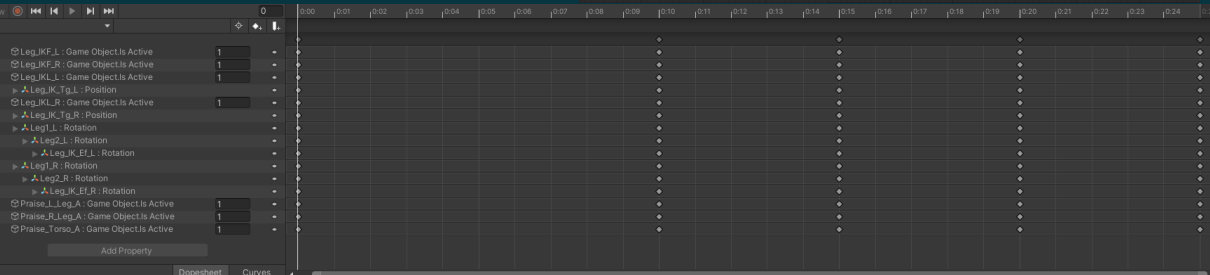
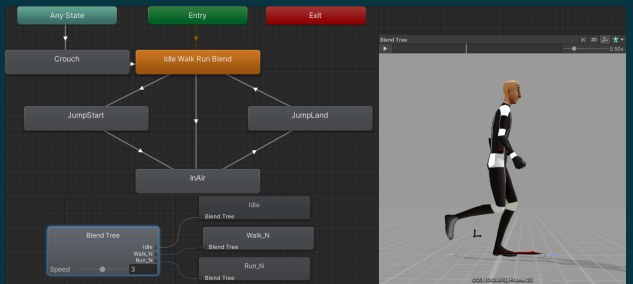
3D ANIMATION

- Skeletal Animation
- Supported Formats
- Forward & Inverse
- Bone Constrains
- IK Rigging



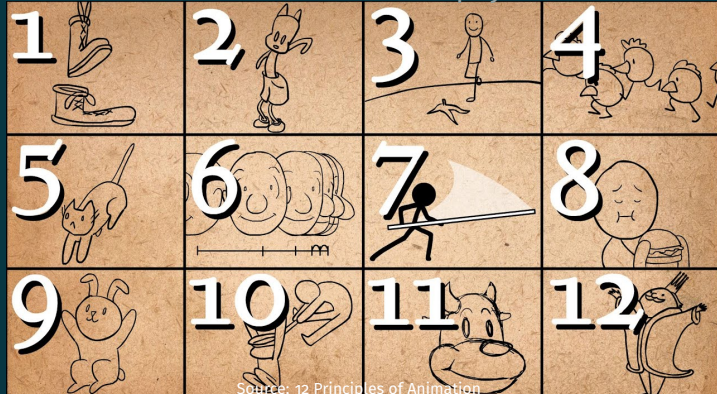
TIMELINE AND ANIMATOR

- Animation Workflow
- Clips, Interpolation & Blending
- Timeline Automation
- Animator Logic



ADDITIONAL RESOURCES

- [YouTube] Aladdin: Cel animation in video games
- [Book] Disney Animation: The Illusion of Life (12 Principles)
- [YouTube] Alan Becker: 12 Principles of Animation
- [YouTube] Jake Clark: Cuphead's Animation Process and Philosophy



Source: 12 Principles of Animation



Thanks For
Your Attention!

The Neverhood

REFERENCES I

- [1] JASON GREGORY. ***GAME ENGINE ARCHITECTURE, SECOND EDITION***. 3rd. USA: A. K. Peters, Ltd., CRC Press, 2018. ISBN: 1351974288.