

# SCENE DYNAMICS

ANIMATION, SKELETON, TIMELINE

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# **MAKING THINGS MOVE**

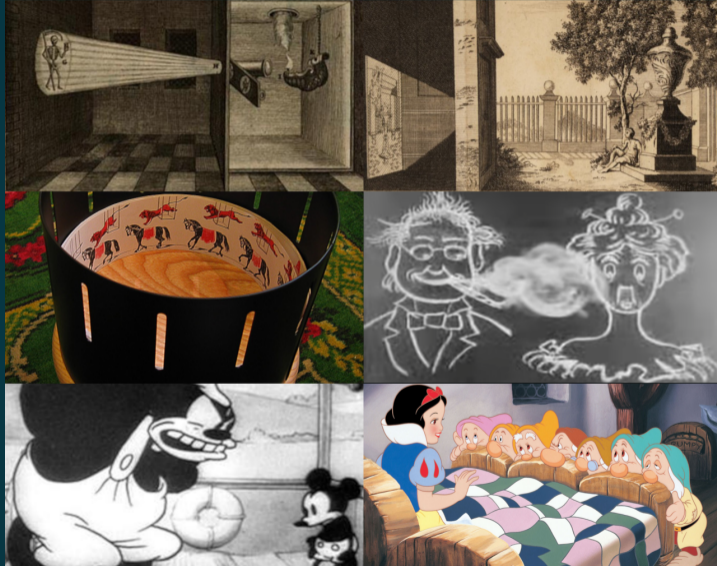
# EVOLUTION OF ANIMATION

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



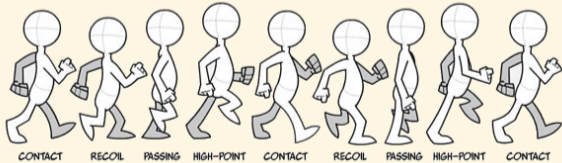
# HUMBLE BEGINNINGS

- [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)

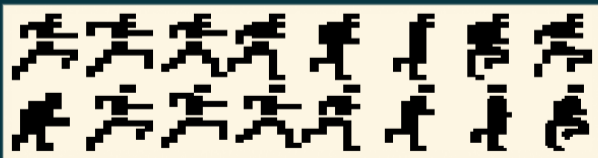


Source: Brandon Kouri: Snow White Cel Animation

# 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
- Digitized Animation



Source: Cuphead – The animation process

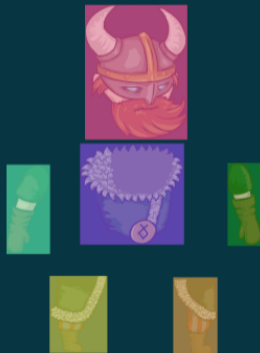
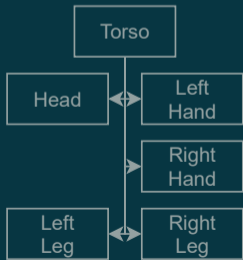


Source: Doom



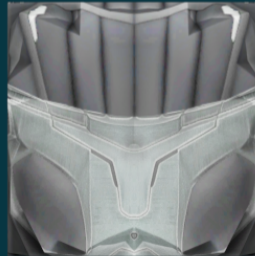
# RIGID ANIMATION

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



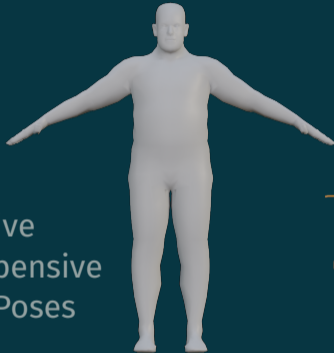
# MOVING VERTICES

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



# ANIMATION AS COMPRESSION

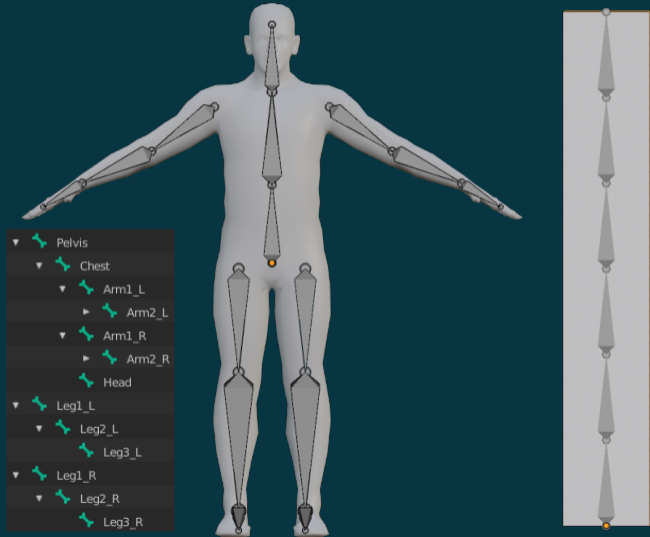
- Limited Resources
  - Time is Money
  - Ease of Use
  - Semantic Manipulation
- 
- Full  $\rightsquigarrow$  Difficult & Time Intensive
  - Vertex  $\rightsquigarrow$  Computationally Expensive
  - Morph  $\rightsquigarrow$  Fitting Task, Needs Poses
- 
- $\Rightarrow$  Skinned Skeletal Animation



Source: Andy Goralczyk: Vincent

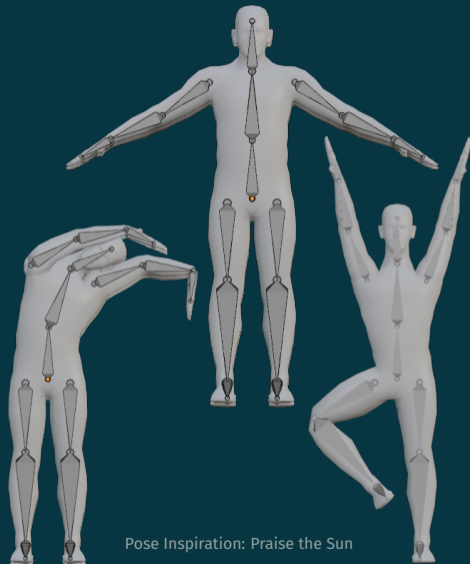
# THE SKELETON

- 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

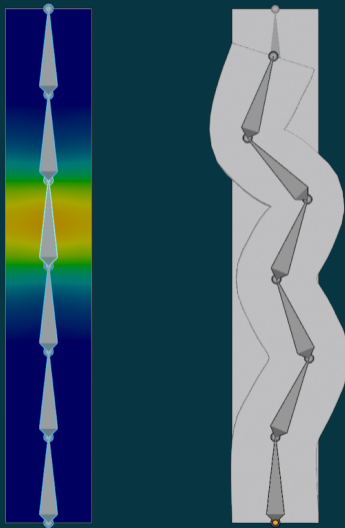
# ANIMATION CLIPS

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



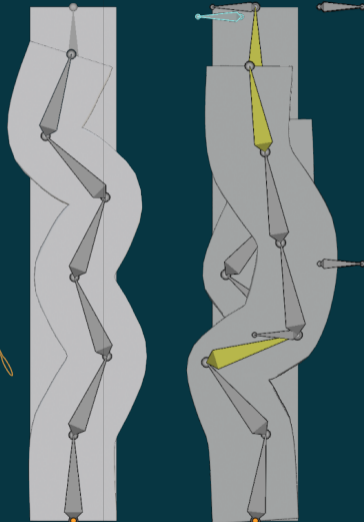
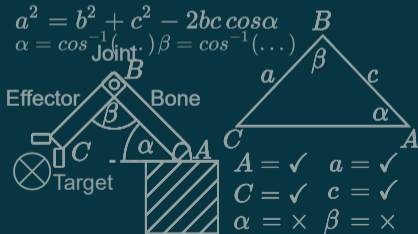
# SKINNED ANIMATION

- Bones → Mesh
- 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

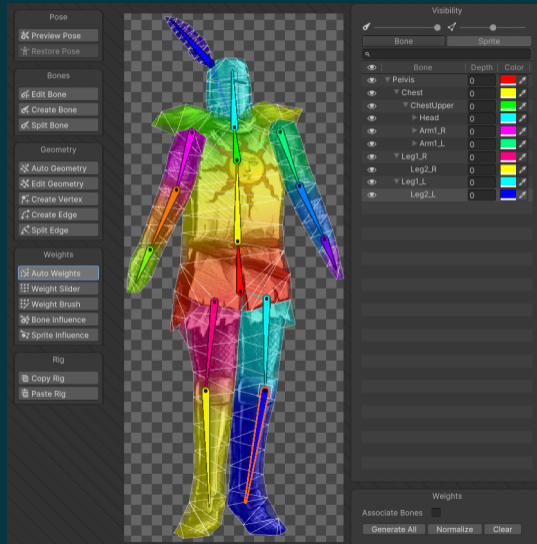




# ANIMATION IN UNITY

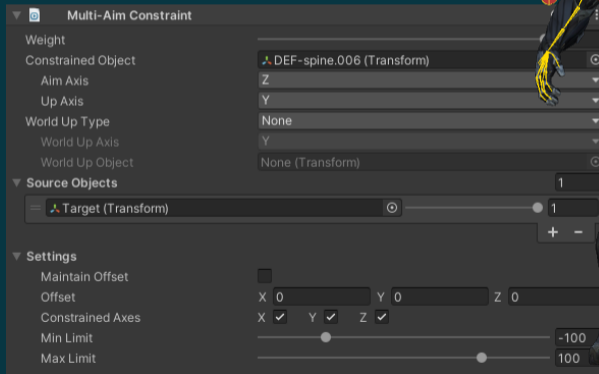
# 2D ANIMATION

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



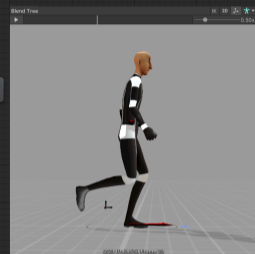
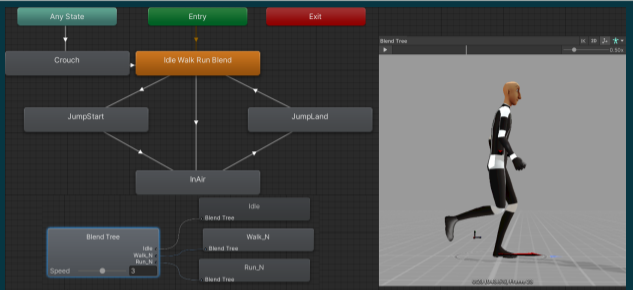
# 3D ANIMATION

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



# TIMELINE AND ANIMATOR

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



Timeline: 0:00 0:01 0:02 0:03 0:04 0:05 0:06 0:07 0:08 0:09 0:10 0:11 0:12 0:13 0:14 0:15 0:16 0:17 0:18 0:19 0:20 0:21 0:22 0:23 0:24

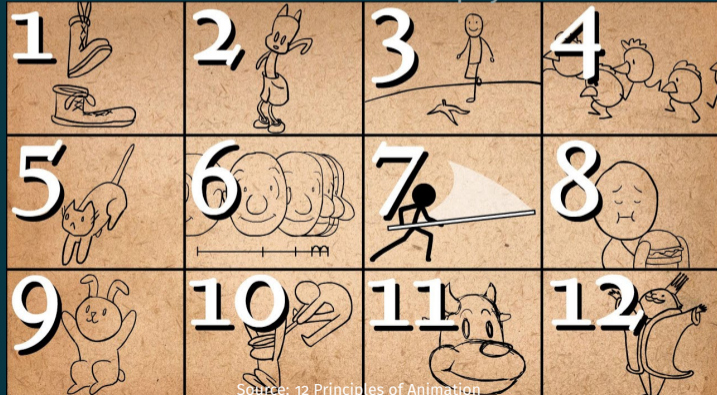
Properties:

- Leg\_IKF\_L : Game Object:Is Active 1
- Leg\_IKF\_R : Game Object:Is Active 1
- Leg\_IKL\_L : Game Object:Is Active 1
- Leg\_IK\_Tg\_L : Position
- Leg\_IKL\_R : Game Object:Is Active 1
- Leg\_IK\_Tg\_R : Position
- Leg1\_L : Rotation
- Leg2\_L : Rotation
  - Leg\_IK\_Ef\_L : Rotation
- Leg1\_R : Rotation
- Leg2\_R : Rotation
  - Leg\_IK\_Ef\_R : Rotation
- Praise\_L\_Leg\_A : Game Object:Is Active 1
- Praise\_R\_Leg\_A : Game Object:Is Active 1
- Praise\_Torso\_A : Game Object:Is Active 1

Buttons: Add Property, Dopesheet, Curves

# 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





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.