

Introduction to Computer Animation

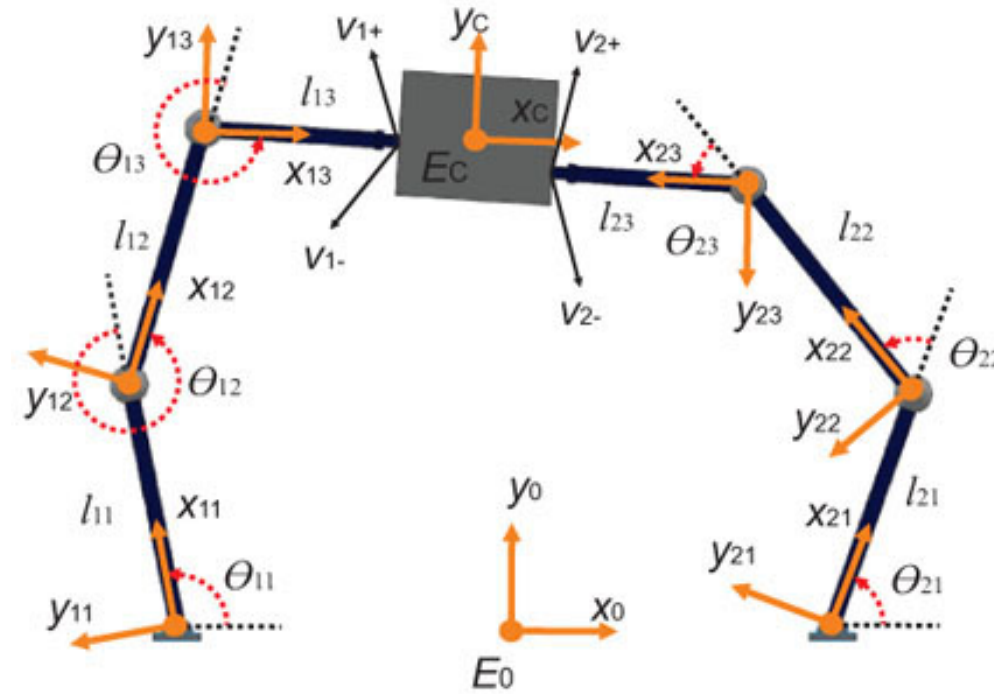
Animation in production

Animation in Computer Graphics

Two main ways to describe animation

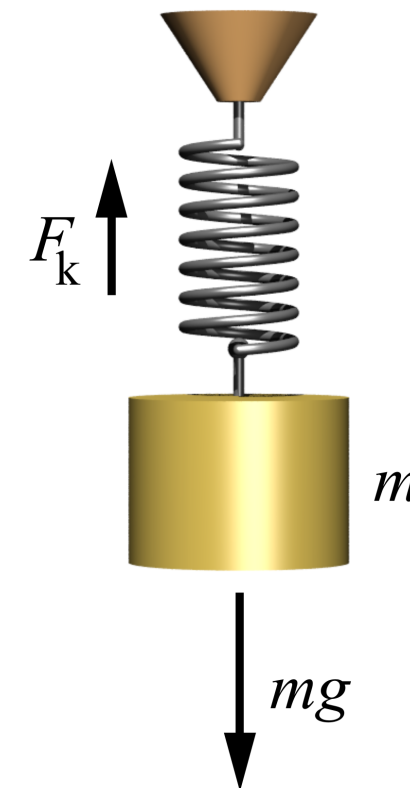
1- Kinematics

Shape deformation/motion without knowledge of the physical cause of the motion



2- Dynamics

Motion through forces acting on shapes (ex. physically based simulation)

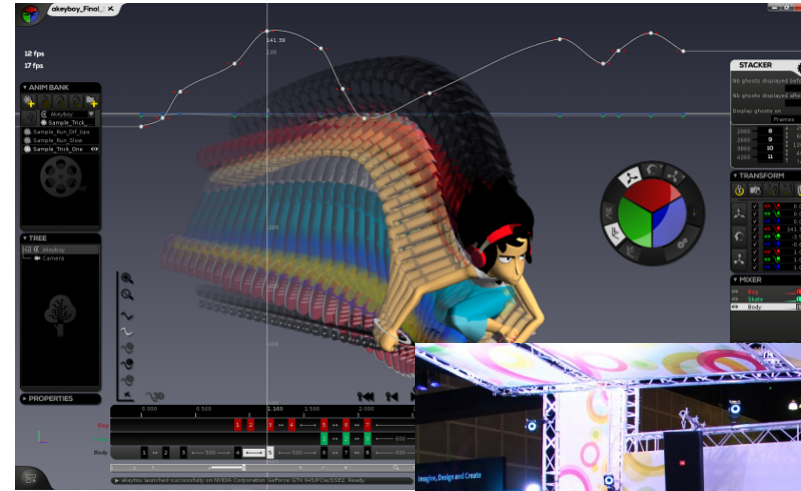


Animation in Computer Graphics

Ways to generate animation

1- Descriptive animation

Fully designed trajectory



2- Motion tracking

Real data aquisition



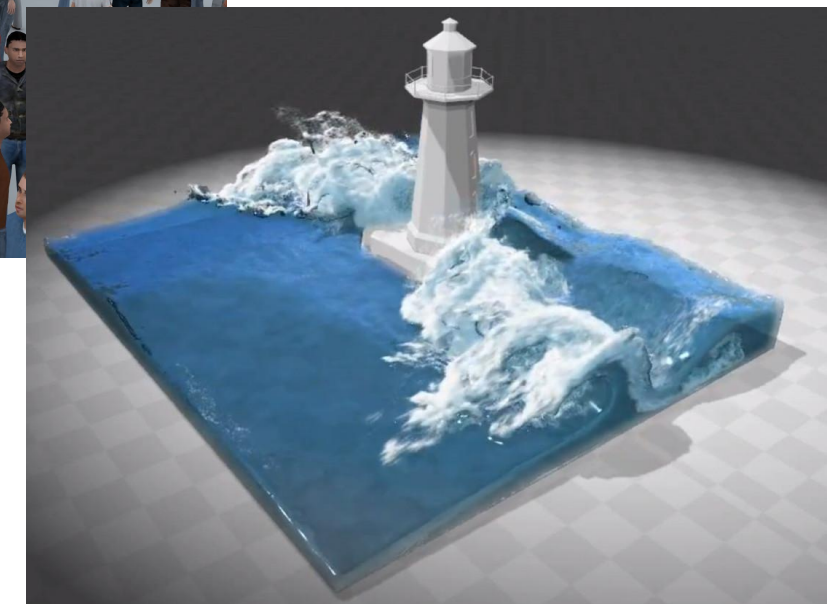
3- Procedural generation

Automatic synthesis



4- Physically based simulation

5- Learning-based synthesis



Descriptive Animation

The artist/an algorithm fully describes the motion and deformation.

pro

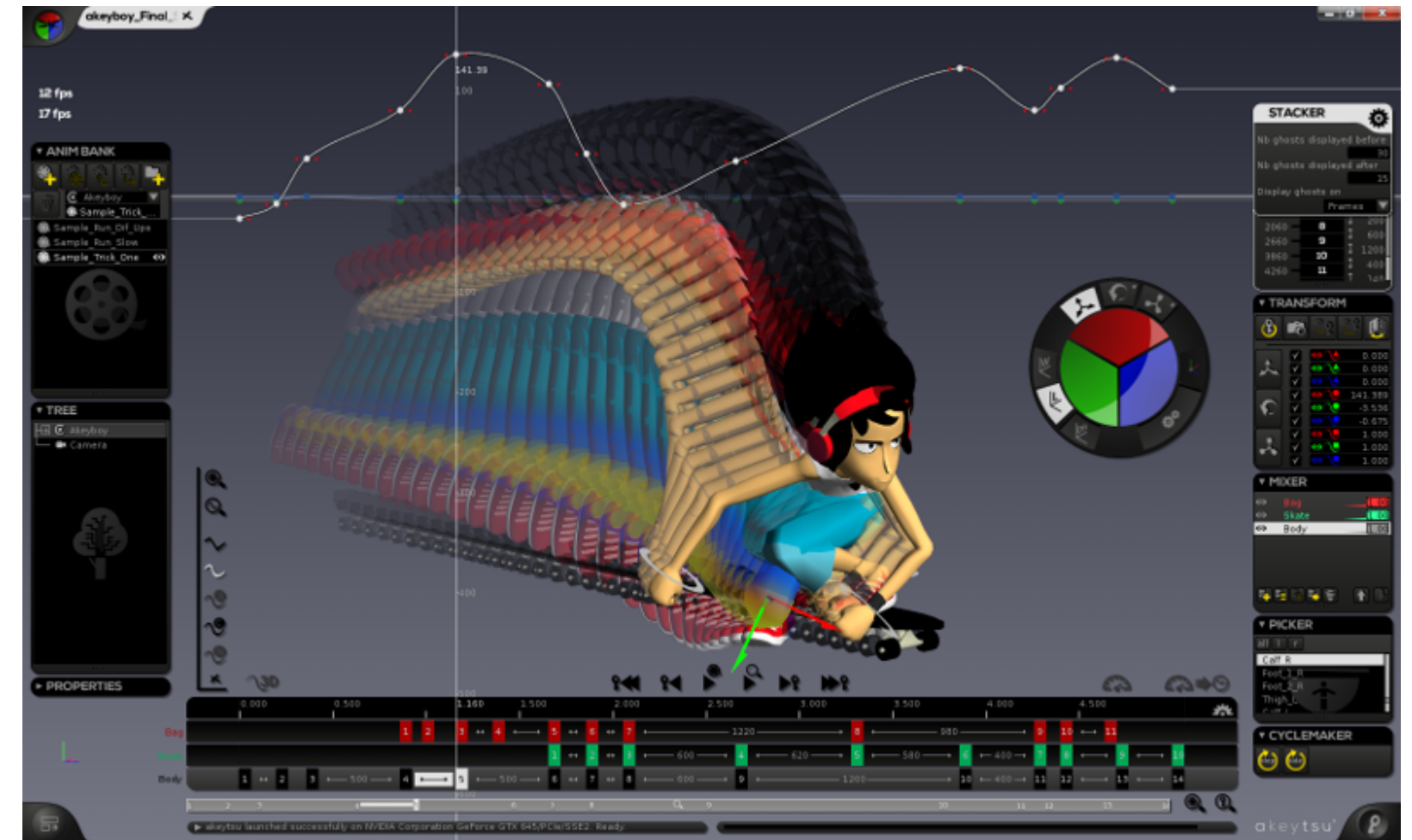
- + Full control on the result

cons

- May introduce un-physical artifacts



© Disney/Pixar



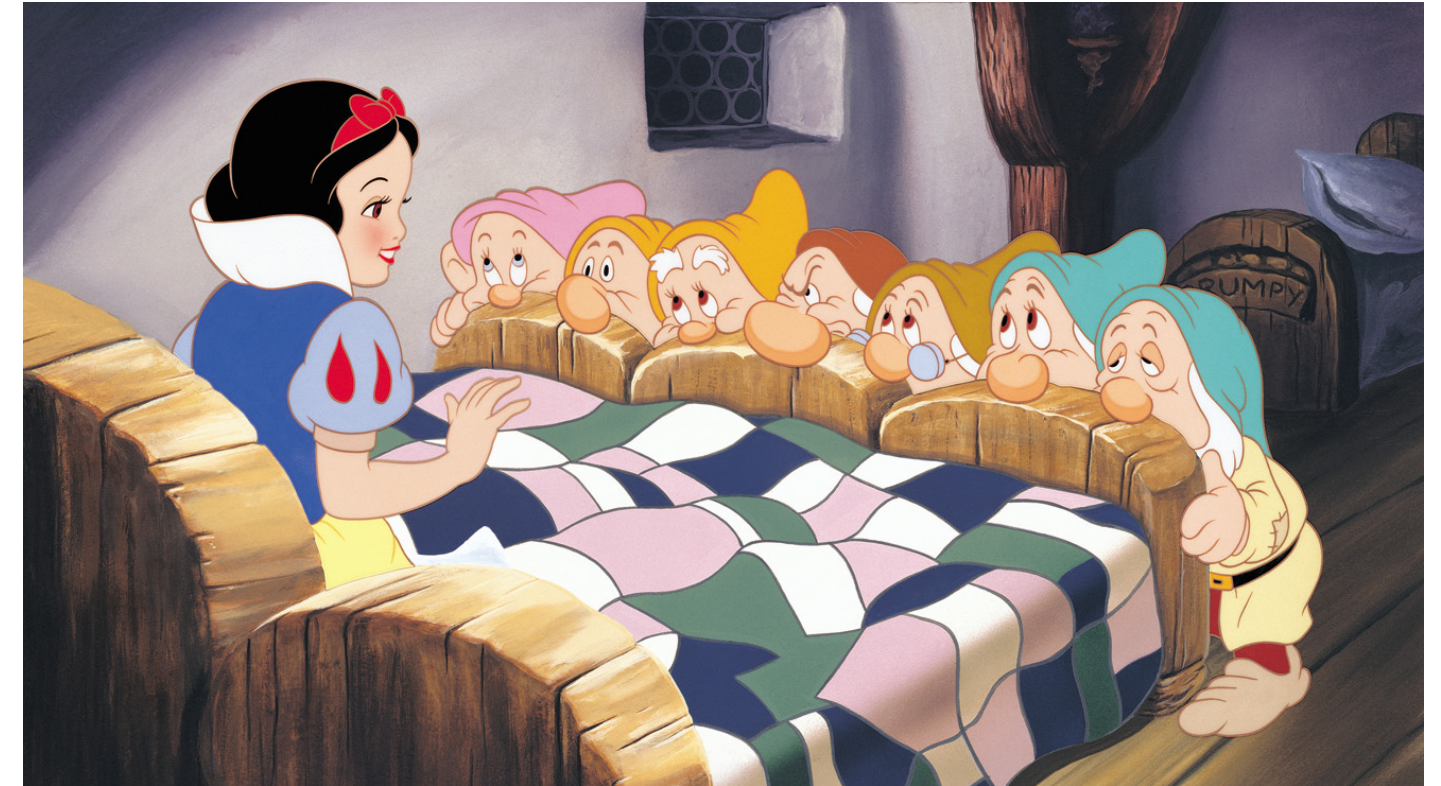
History of CG Animation

First production of animated films (Disney)

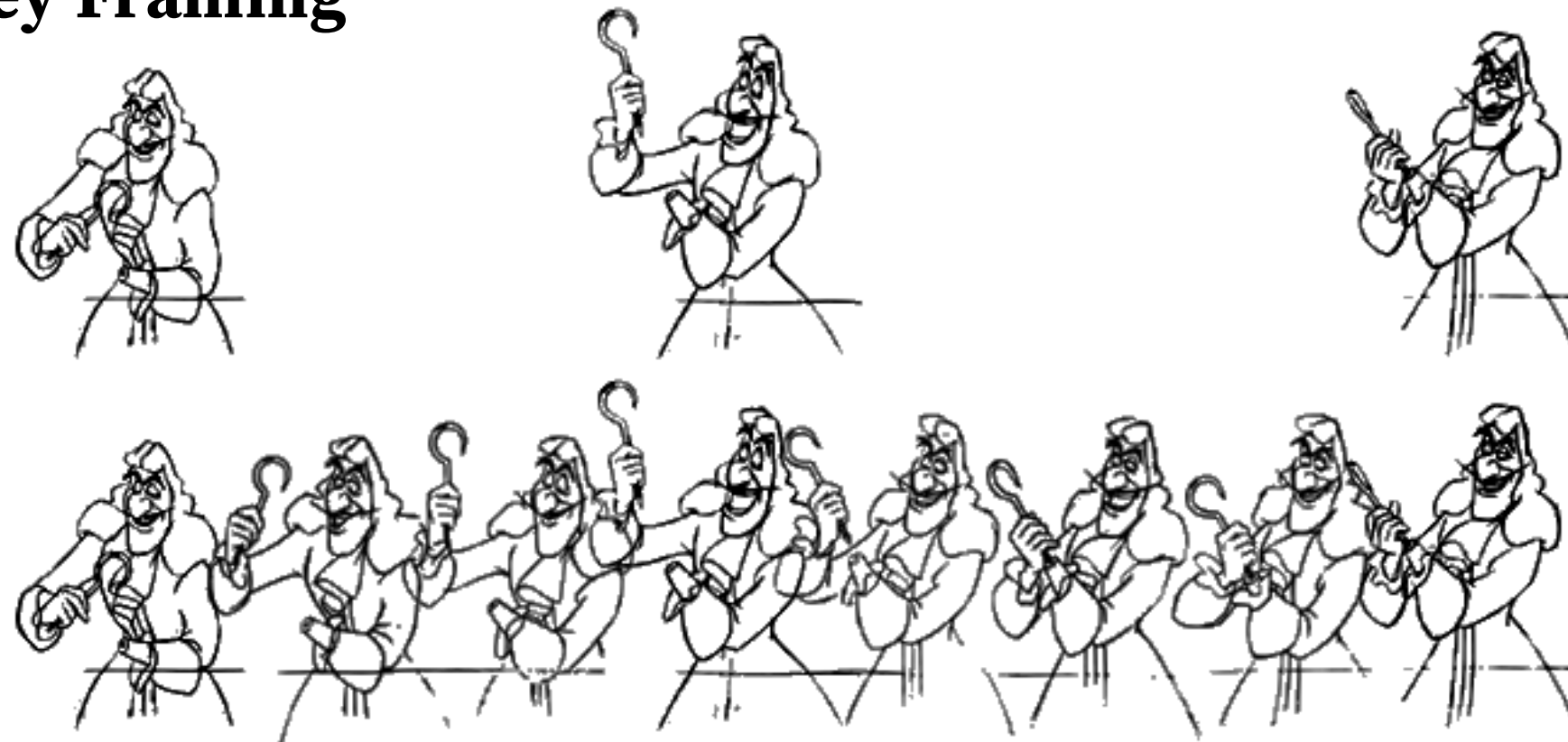
- 30 drawings / sec

Principle

- *Animator in chief*: Create **Key Frames**
- *Assistants*: Fill the *in between* (secondary drawings)



=> Principle of **Key Framing**



(c) Walt Disney Company, from "The Illusion of Life"

Key Framing in CG

- Create *manually* a set of **Key Frames** at specific time steps
- Compute automatically intermediate frames (30 fps) using **interpolation**



Production Pipeline

Production Pipeline

Fundamental structure for VFX/animation movie production.

Pre-production

*Story, script,
concept art*

Storyboard

Animatic

Layout

Production

Special Effects

Modeling

Rigging

Shading

Texturing

Lighting

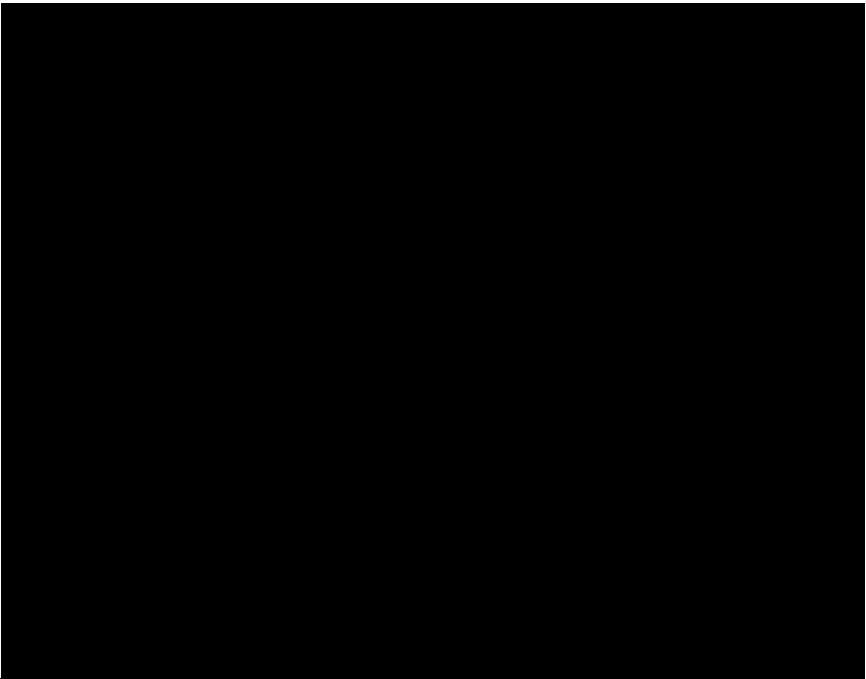
Animation

Rendering

Post-Production

Compositing

Editing



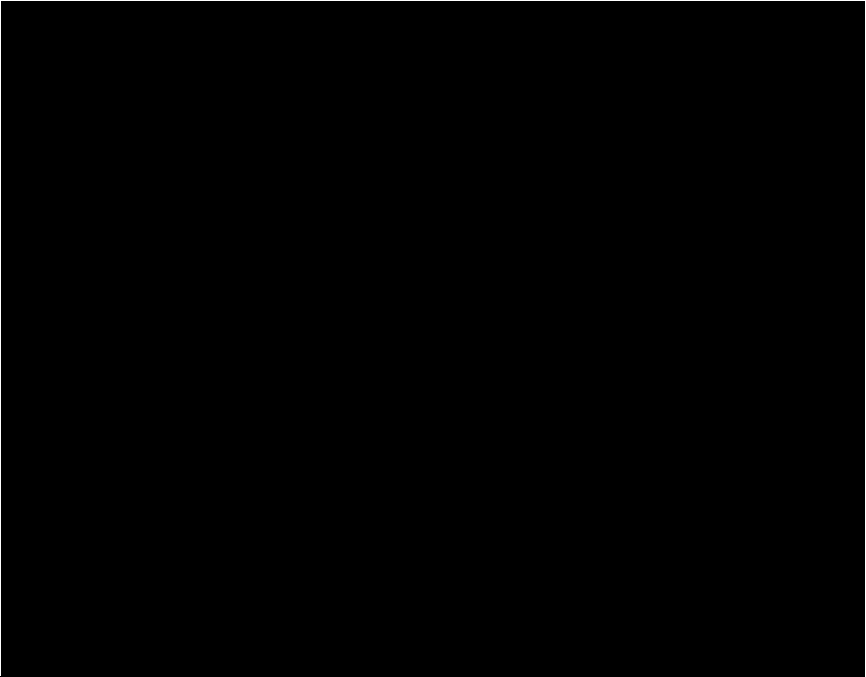


assets/production.svg

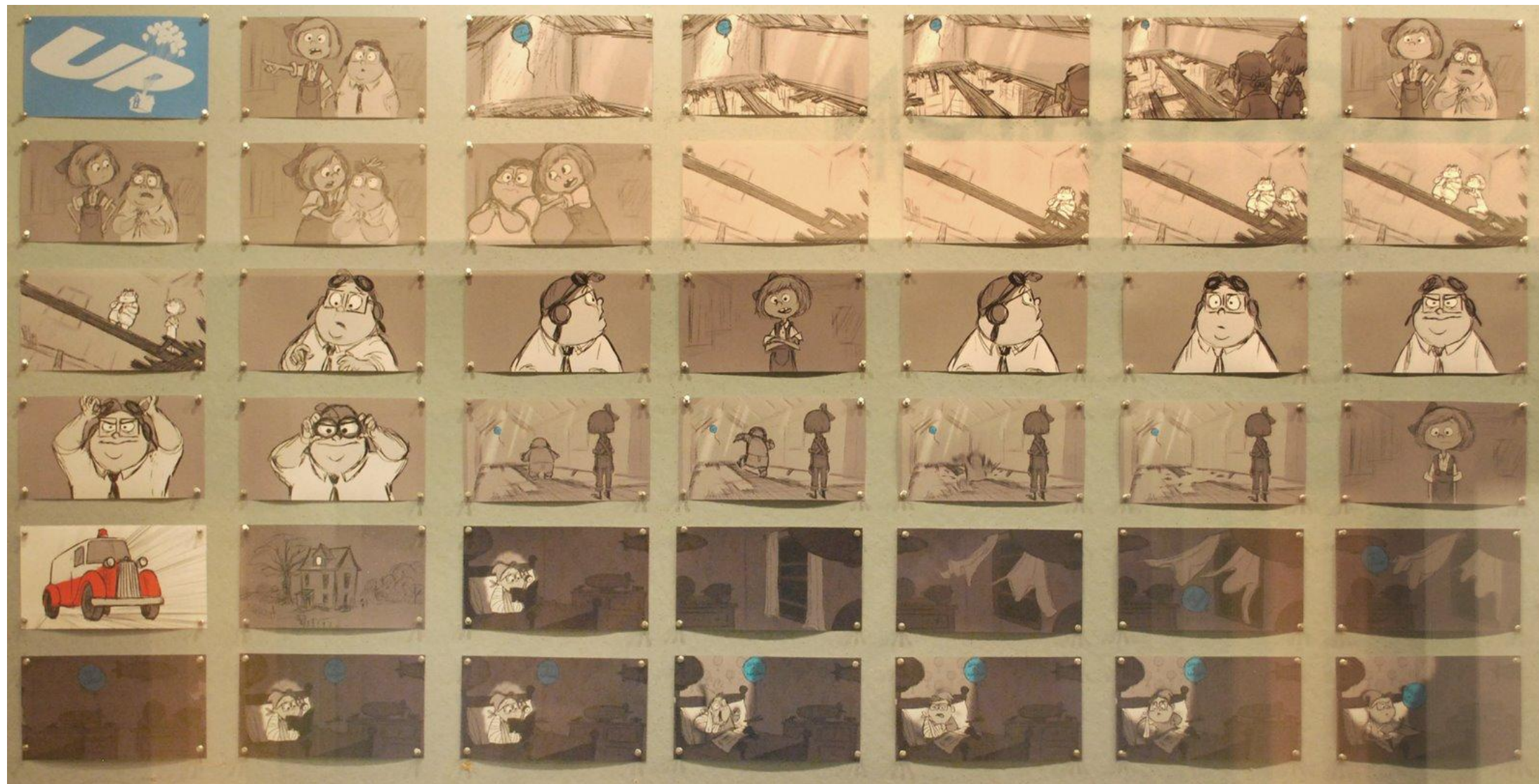
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0:00



Story-board



Few 2D drawings: express the story

Before mostly non-technical - artistic/creative based

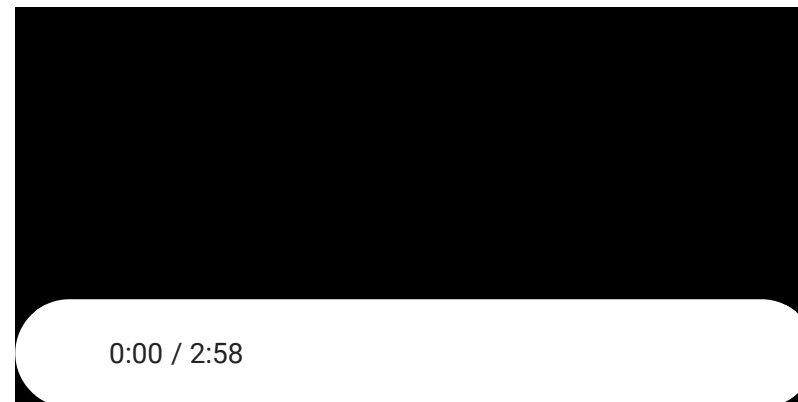
Curently Strong increase of Storytelling-related researchs in CG

ex. Disney Research Studios, Imagine team at Inria

Animatic

≅ Animated story-board, Various format

Rough sense of timing, visual, action: details not necessarily followed precisely in the final version.



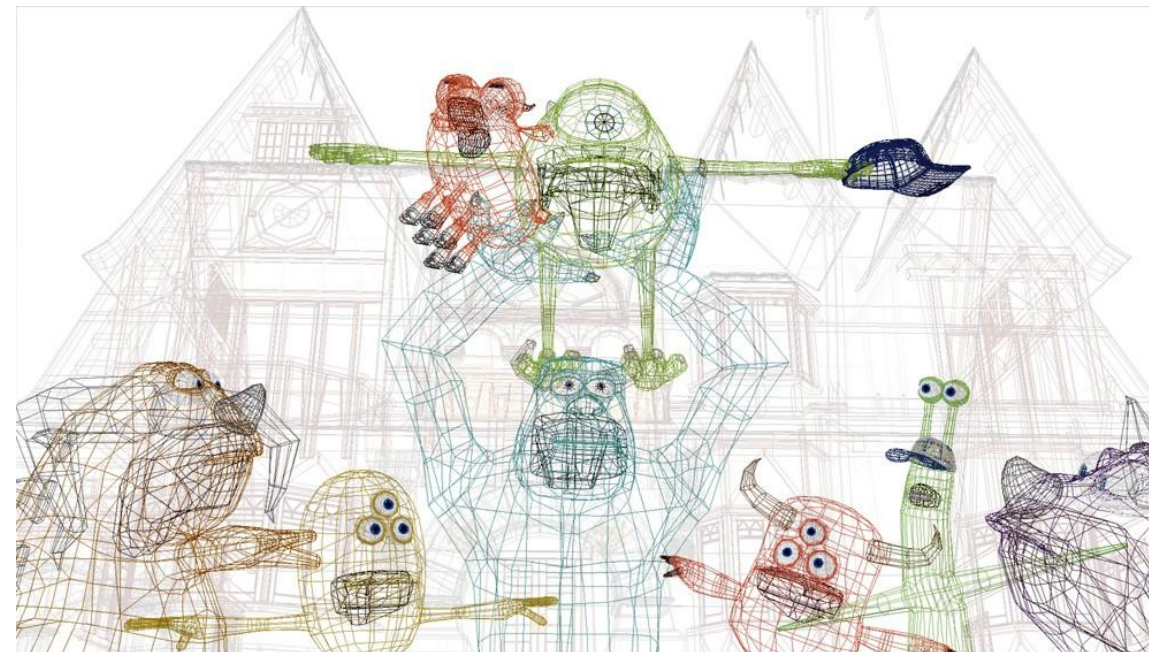
Layout: Moving into 3D

1st step: Rough 3D modeling and placement of

- Camera: visual field, perspective
3D much more constrained than 2D drawings
- Shape volumes, continuity
No details: face, etc.
Choice between 3D/2D elements



"MONSTERS UNIVERSITY" Progression Image 1 of 6: STORY
©2013 Disney•Pixar. All Rights Reserved.



"MONSTERS UNIVERSITY" Progression Image 3 of 6: MODELING
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"MONSTERS UNIVERSITY" Progression Image 4 of 6: LAYOUT
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3D Modeling

In production

- Polygonal mesh modeling

Coarse to fine approach

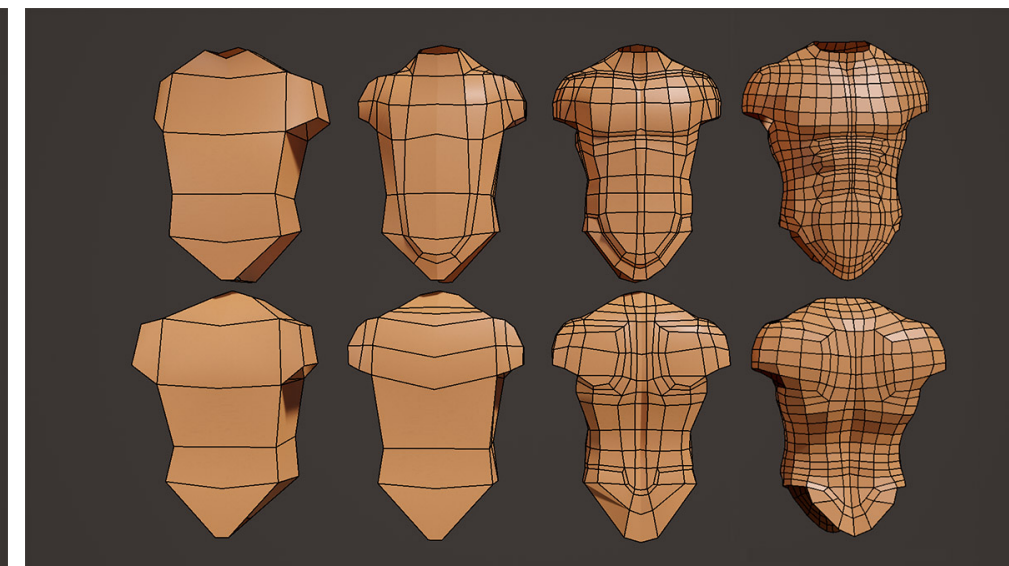
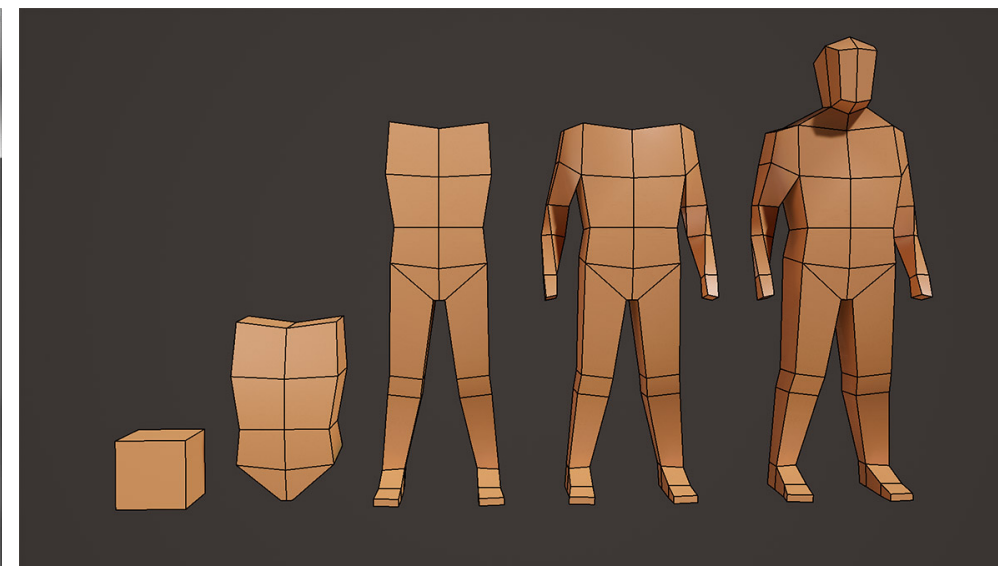
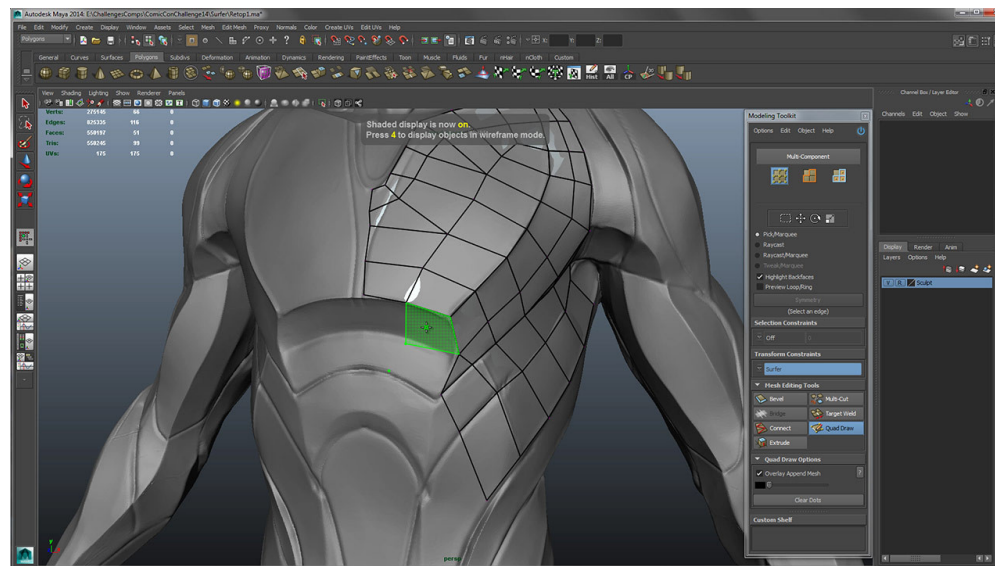
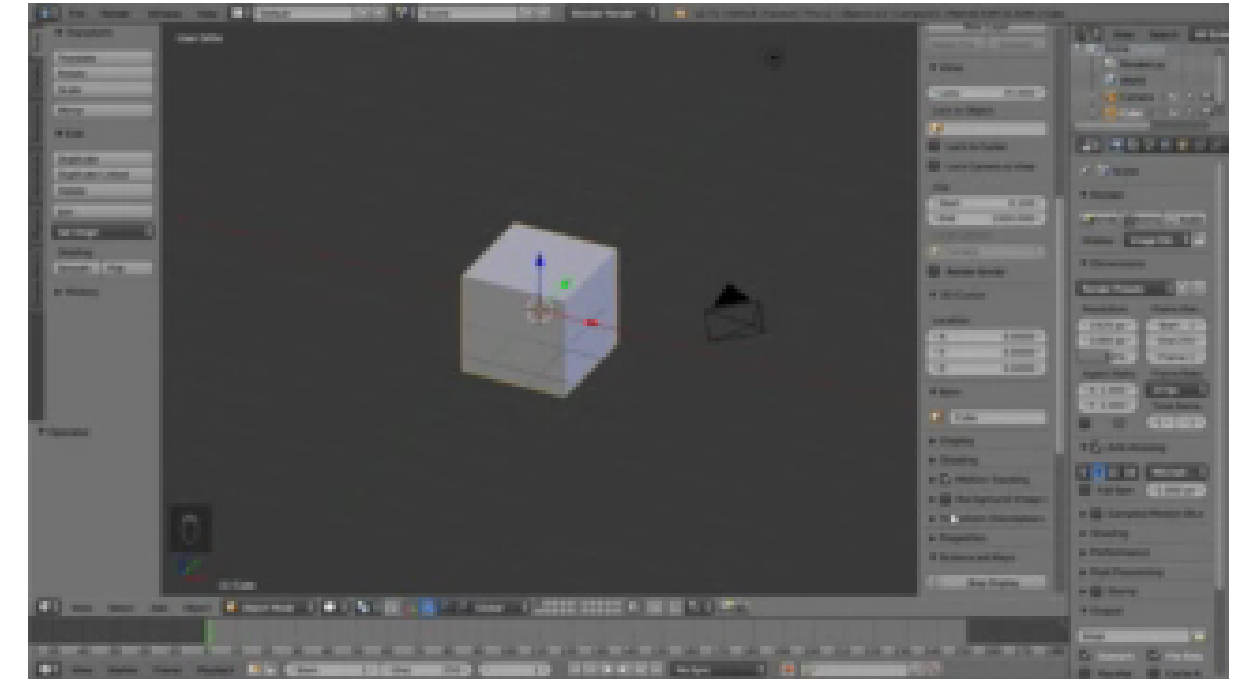
1. Low res modeling (extrusion)

2. Subdivide, Refine

- Parametric (NURBS) modeling

Everything else is "VFX"

Common tools: Maya, 3DSMax, Cinema4D, Blender, etc.



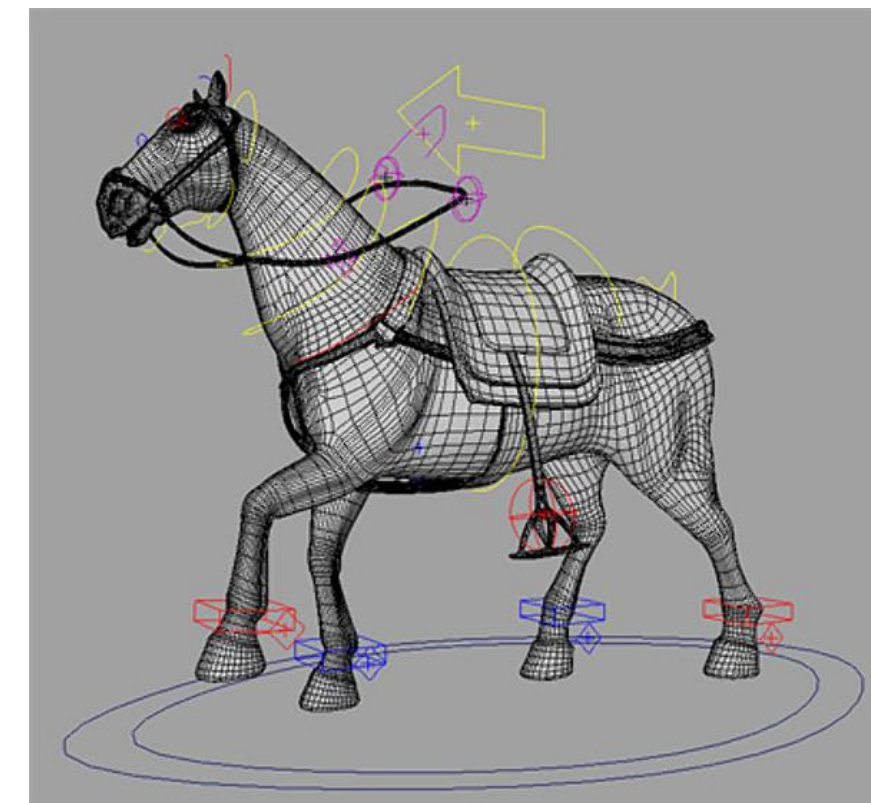
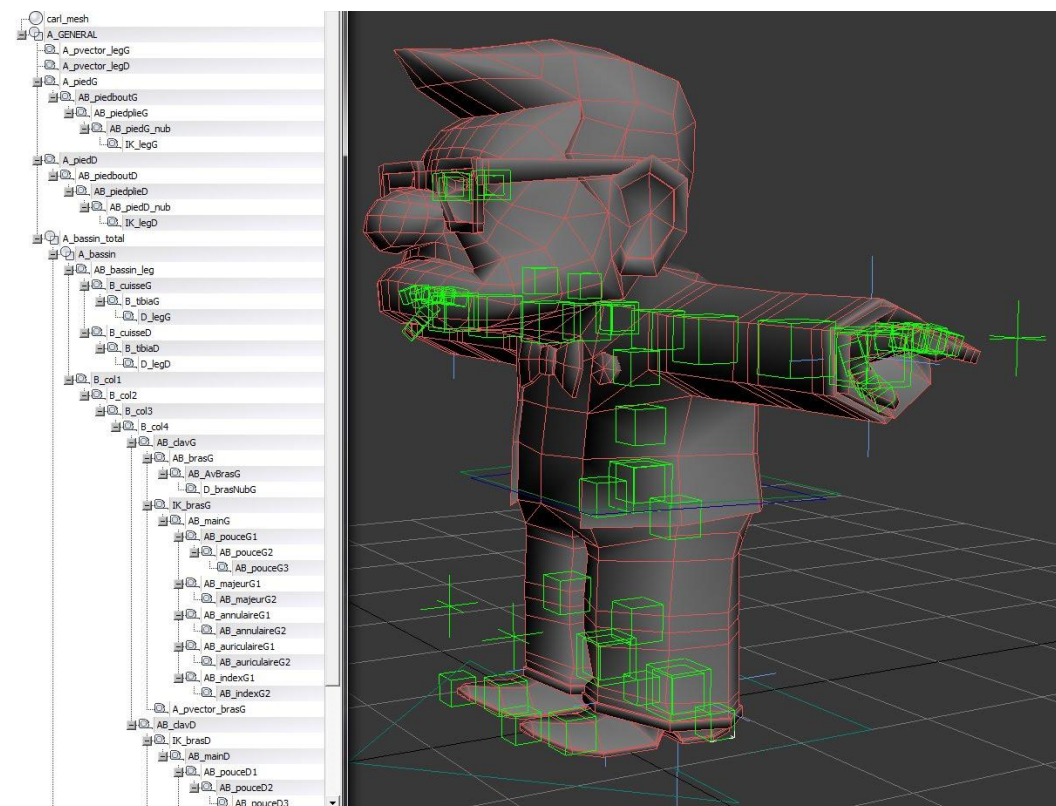
Rigging

Attach deformation handles to the mesh

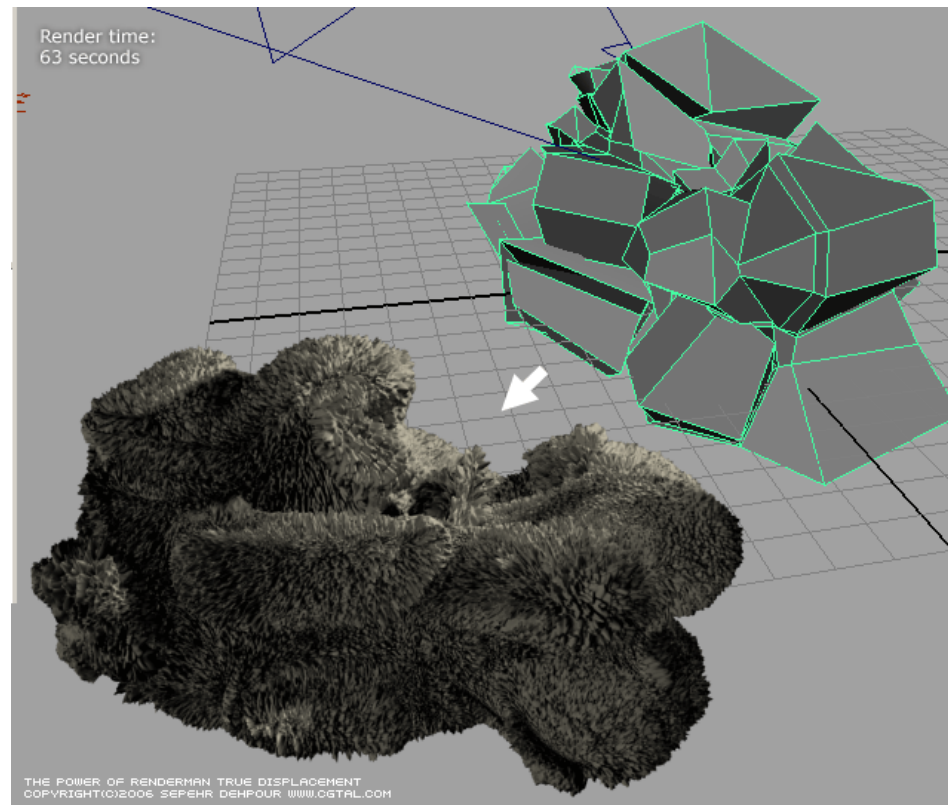
Each handle (controler) is associated to a deformation - degrees of freedom

Rigging is a technical part

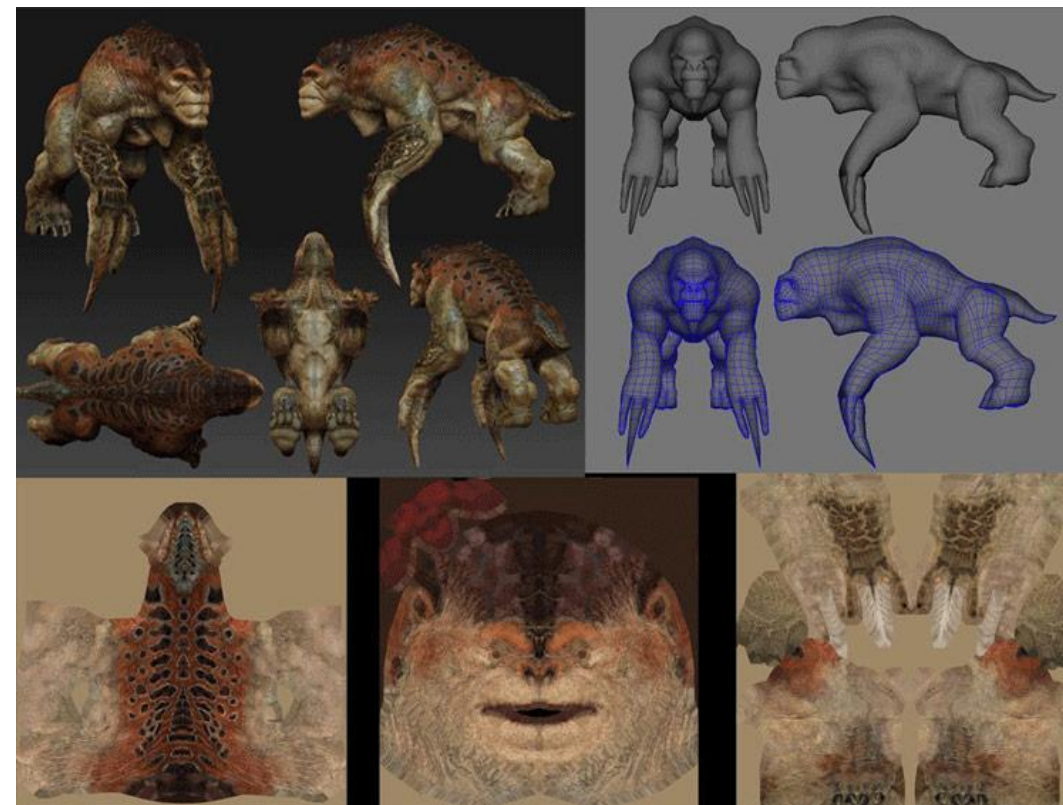
Python script, Mel (Maya), Lua, etc.



Modeling appearance - Rendering purpose



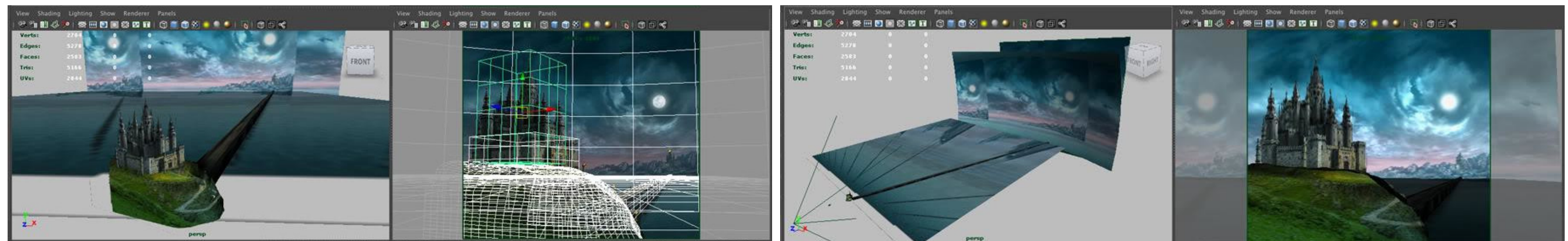
Shading



Texturing



Lighting



Mate painting

Animation

In production terminology: Animation = Key-frame animation of the rigged character

Set animation curves on rig controlers

Everything else is VFX

0:00

Animating the walk cycle ($\times 40$)

Up to 75% of artists production studios are animators

Animation = The key element - higher cost - for production studios

One animator $\rightarrow$ 1-10 s of animation per day

0:00

Result

Animation sub-parts

1- **Posing** the *key frames*

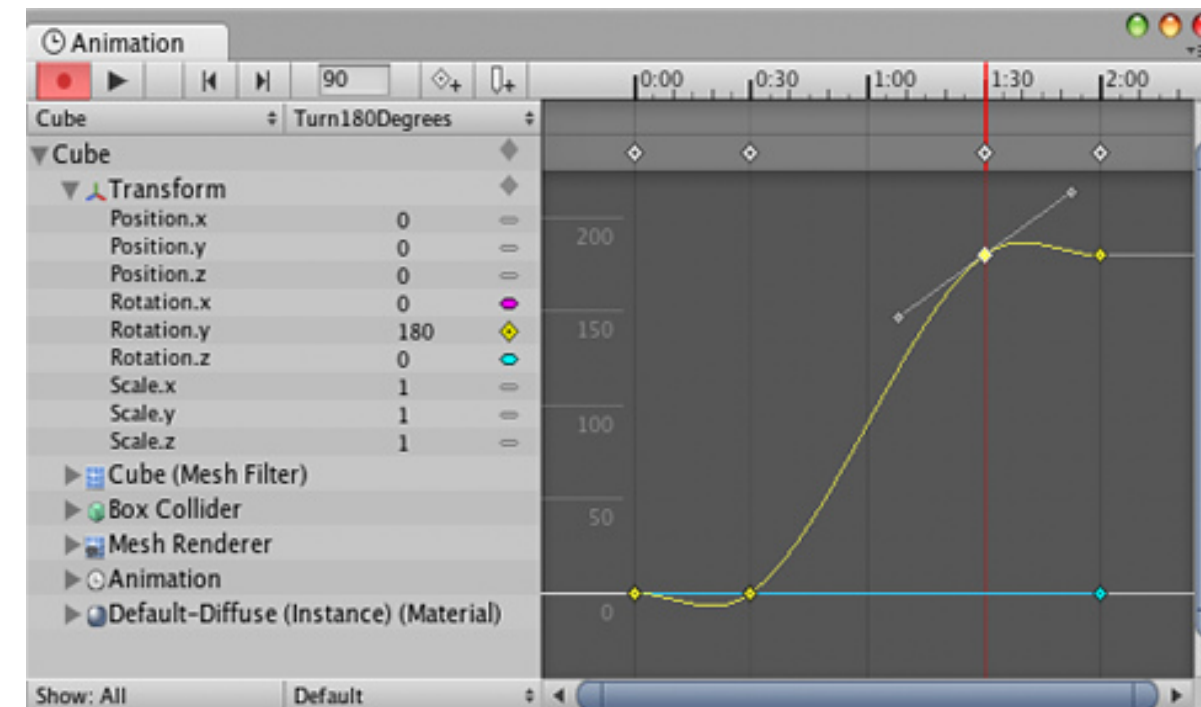
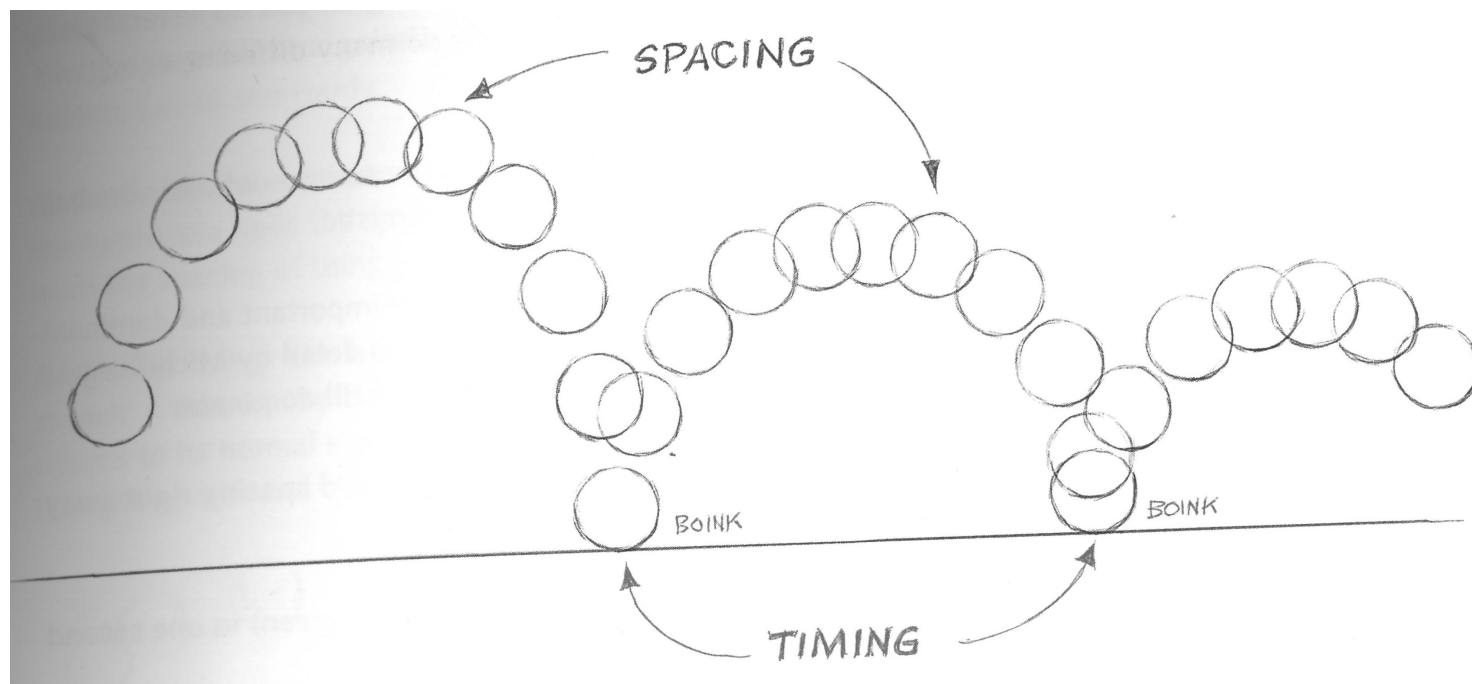
Set the main general posture of the character

*Linked to geometric **character deformation**, time is not involved*



2- **Animating** the in-betweens

- **Timing** : Place key frames at specific times (global length of an action)
- **Spacing** : Speed of the interpolation (dynamic of the action)



Special Effects (VFX)

Everything which is not handled by traditionnal modeling/rigging/animation

Physics (explosion, fluids, dynamic hairs, cloth, ...), particles systems, complex shape, crowd, etc.

Technical R&D part: One element can lead to the development of a dedicated system.

Main software: Houdini (SideFX)

0:00



Post Production

Compositing

Blend all layers: Rendered and real ones

Note: Rendering of color layers but also depth and normals.

Main software: Nuke (Foundry)

0:00



Expressive animation

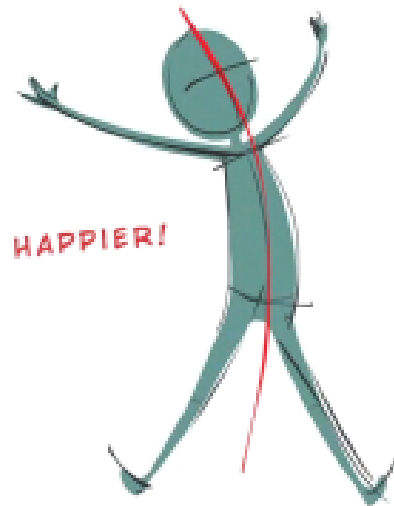
Character Animation Posing - Line of Action

- Line of action: *Medial axis* expressing the character pose
- Express *statically* the dynamic of the action
 - Unstable pose $\Rightarrow$ Dynamic action/motion

SLIGHT CURVE



HAPPIER!

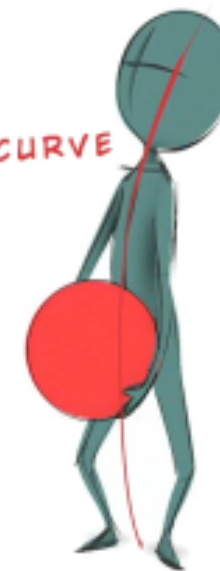


EXAGGERATED
HAPPY POSE



SLIGHT CURVE

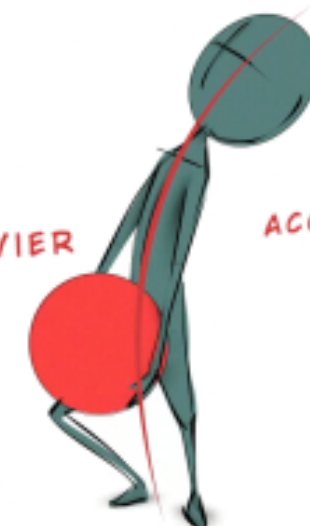
SEEMS LIGHTER



EXAGGERATED EFFORT POSE

SEEMS HEAVIER

ACCENTUATED
CURVE



SLIGHT CURVE



ACCENTUATED
CURVE



EXAGGERATED
SAD POSE



Principles of animation

- Interpolation between realistic poses isn't enough for expressive animation
- *12 principles of animation* by Disney *Illustion of Life*, 1981

1. Timing
2. Spacing
3. Slow-in, Slow-out
4. Squash & Stretch
5. Anticipation
6. Follow Through
7. Secondary Action
8. Exaggeration
9. Appeal
10. Arcs
11. Staging
12. Straigh Ahead/Pose to Pose

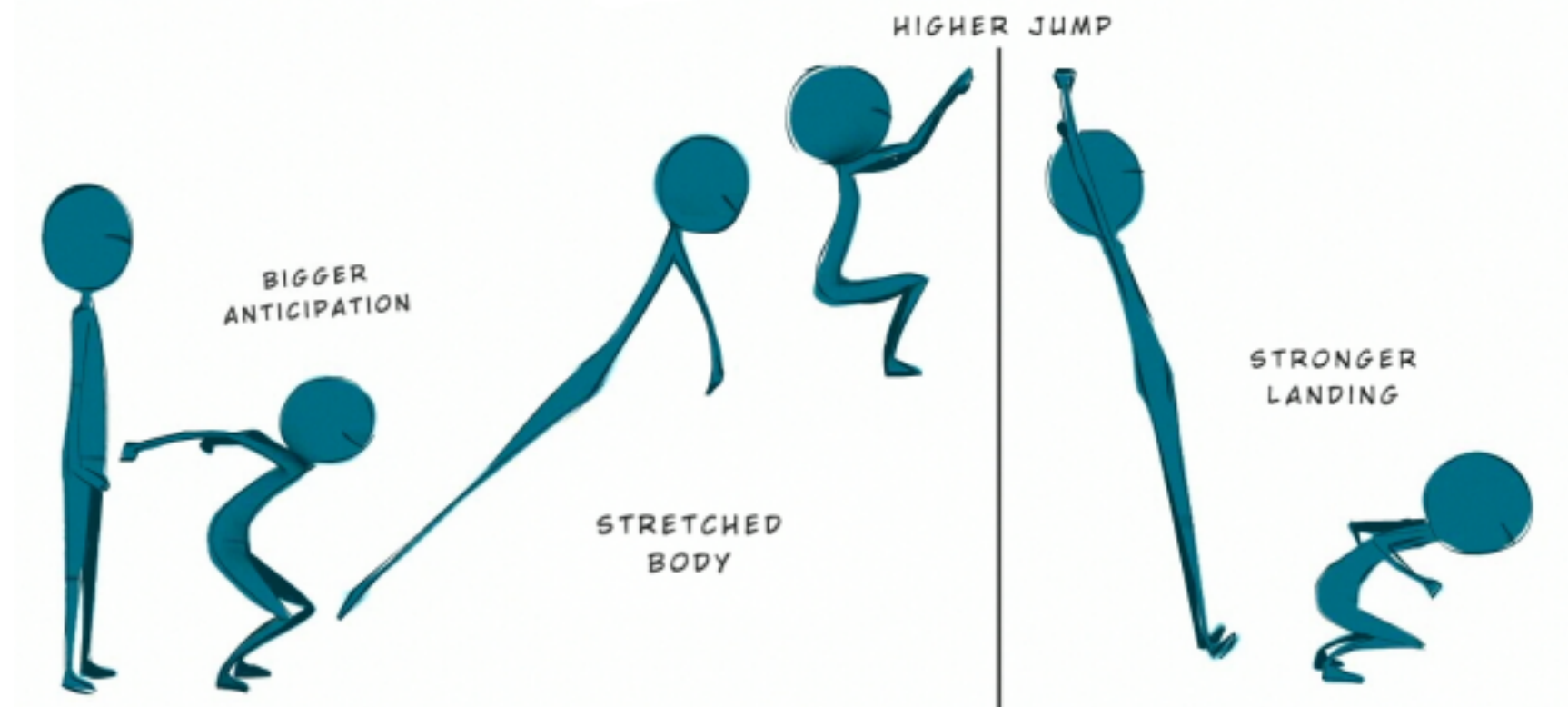
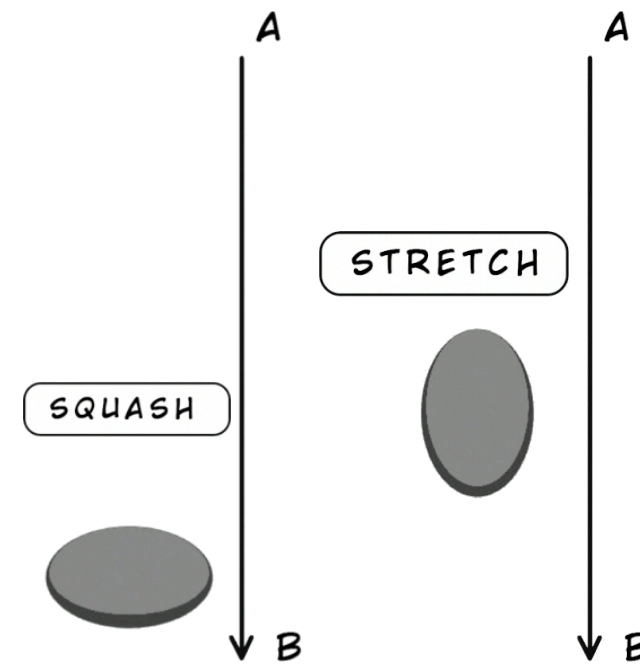


(C) Chiara Porri

Expressive animation

Squash & Stretch

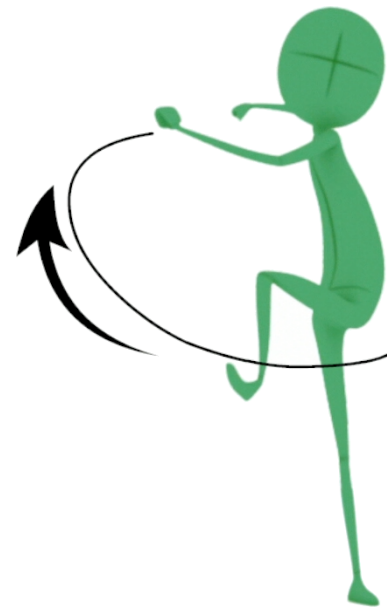
- Very common in cartoon
- Unrealistic, but surprisingly *plausible*



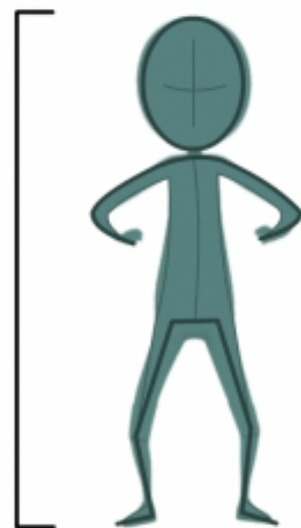
(C) Chiara Porri

Expressive animation

Anticipation

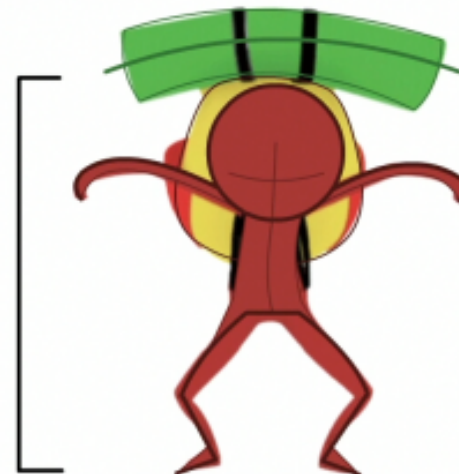


the character is pretty light



Softer Anticipation

the character is bringing
an heavy object

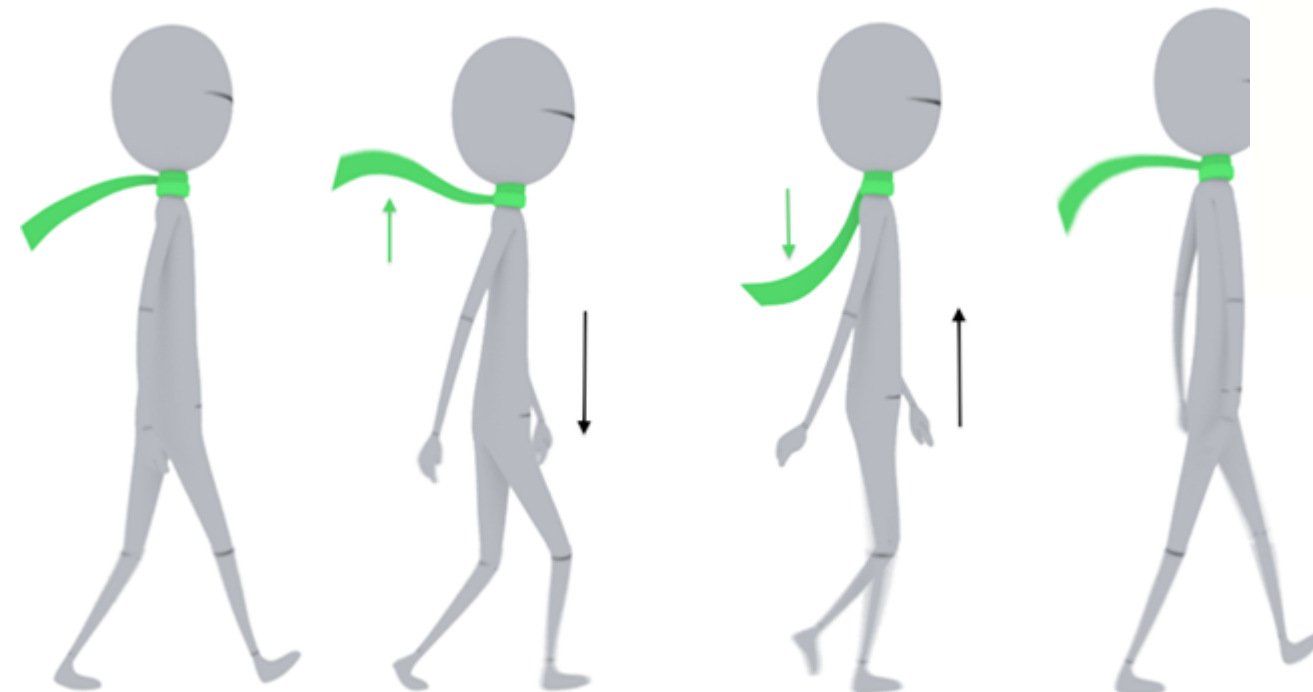
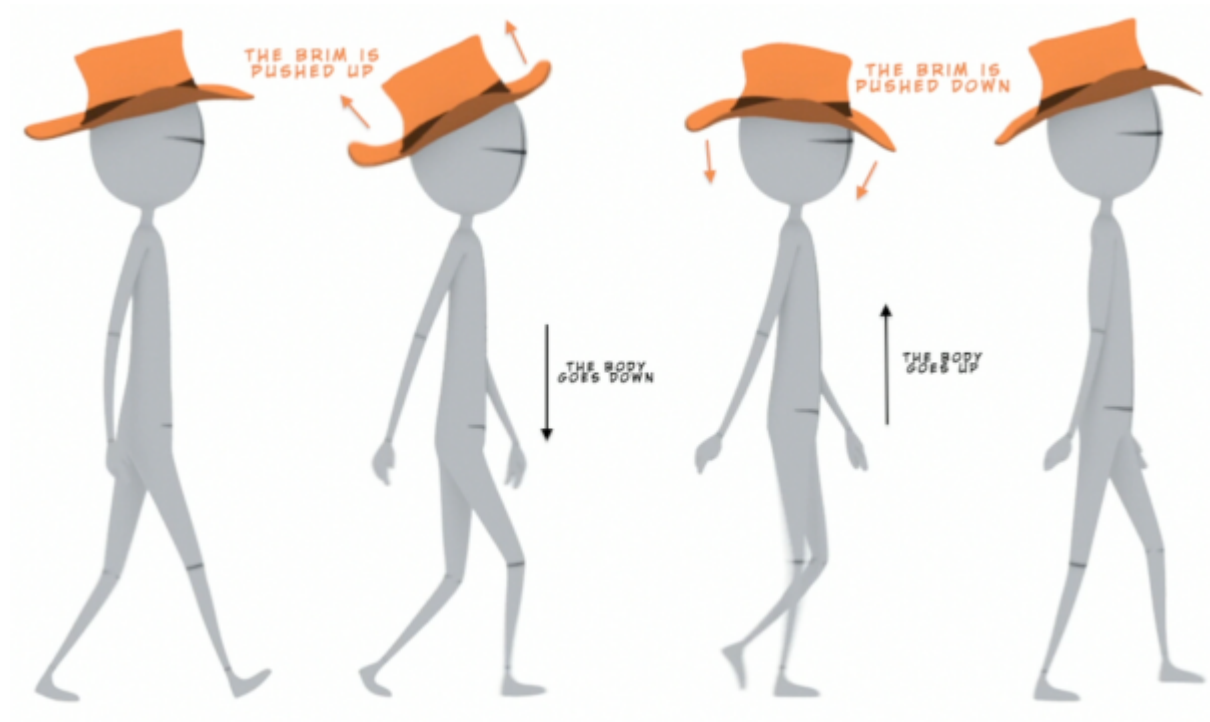


Stronger Anticipation



Expressive animation

Follow Through / Secondary motions



(C) Chiara Porri