Intermediate Graphics & Animation Programming

GPR-300
Daniel S. Buckstein

The Principles of Animation
Weeks 10 – 11

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Principles of Animation

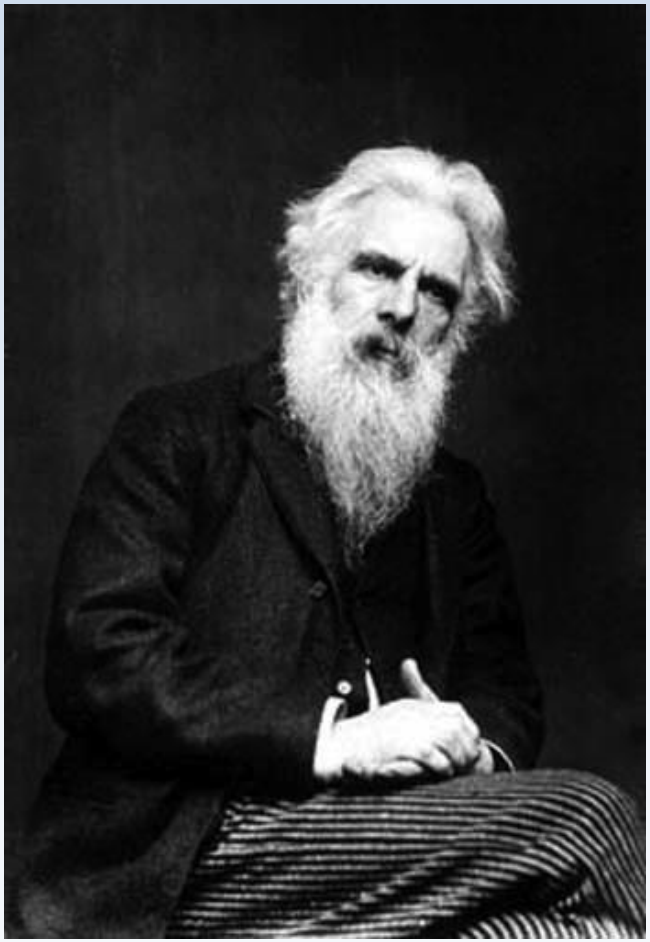
- Intro to Animation: A Brief History
- Locomotion vs. Animation
- The 12 Principles of Animation
- Applications

Intro to Animation: A Brief History

- It is hard to say where animations began.

Intro to Animation: A Brief History

- Let's start with a guy called ***Eadweard Muybridge***
- English photographer, famous for…?
- Studies in *motion* and *early film and motion pictures*



Intro to Animation: A Brief History

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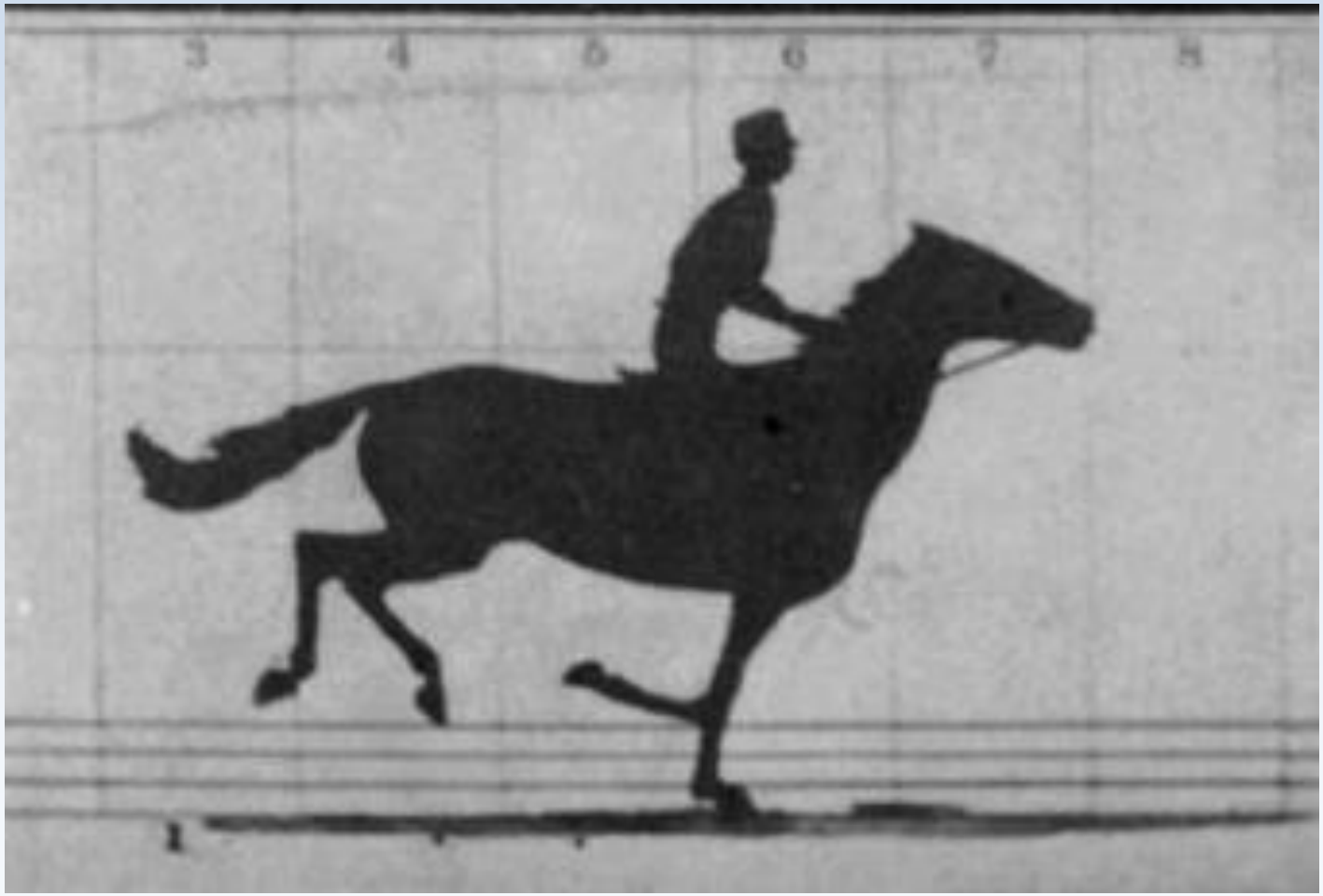
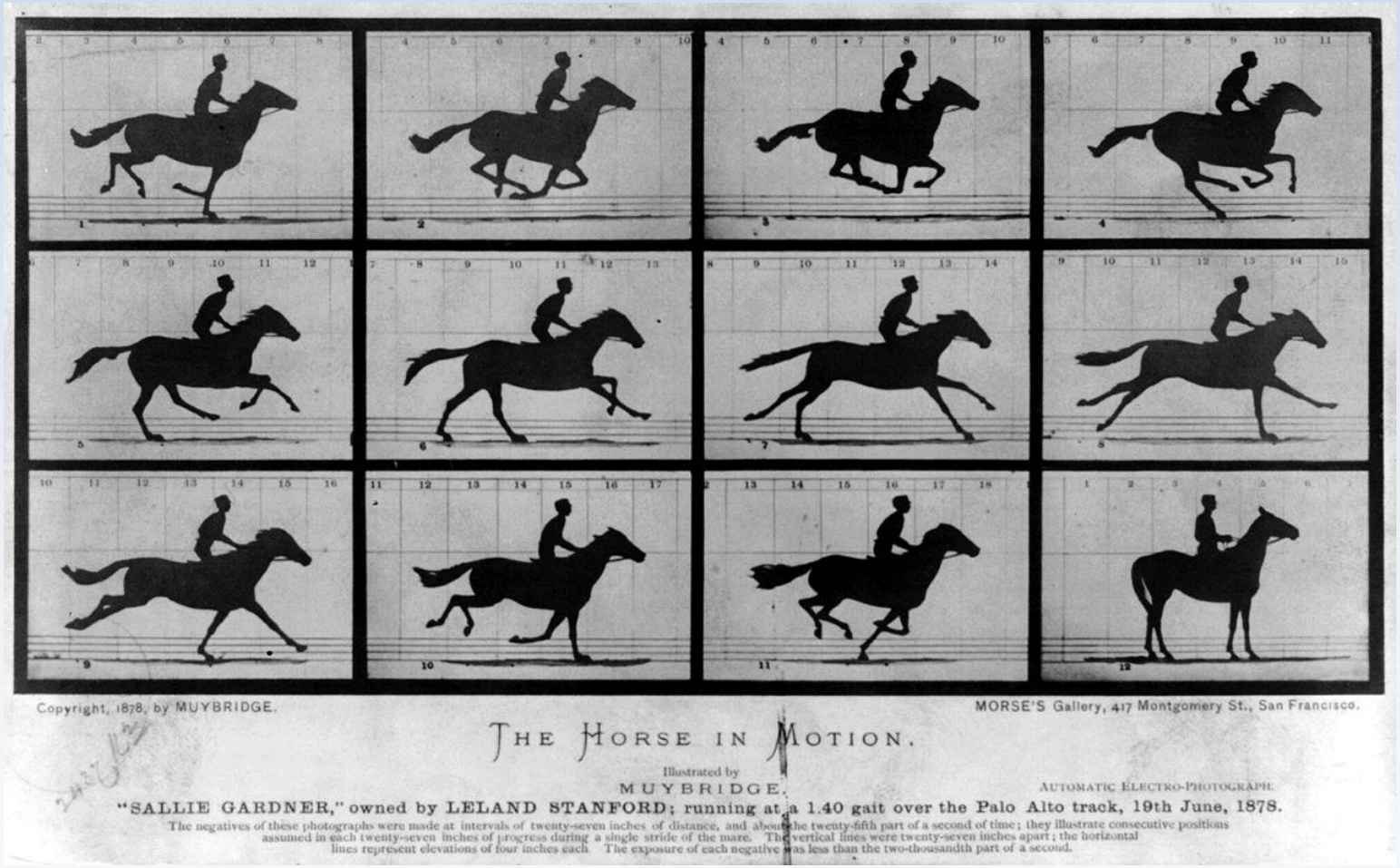
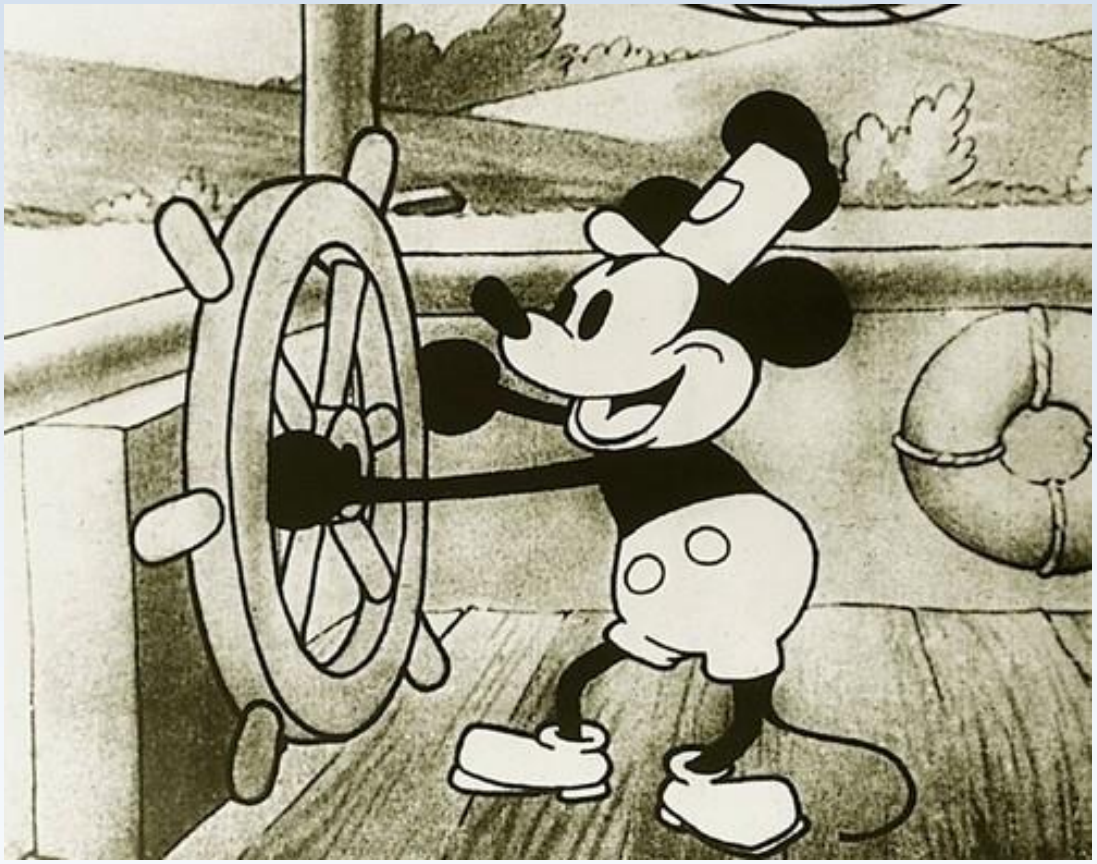


Intro to Animation: A Brief History



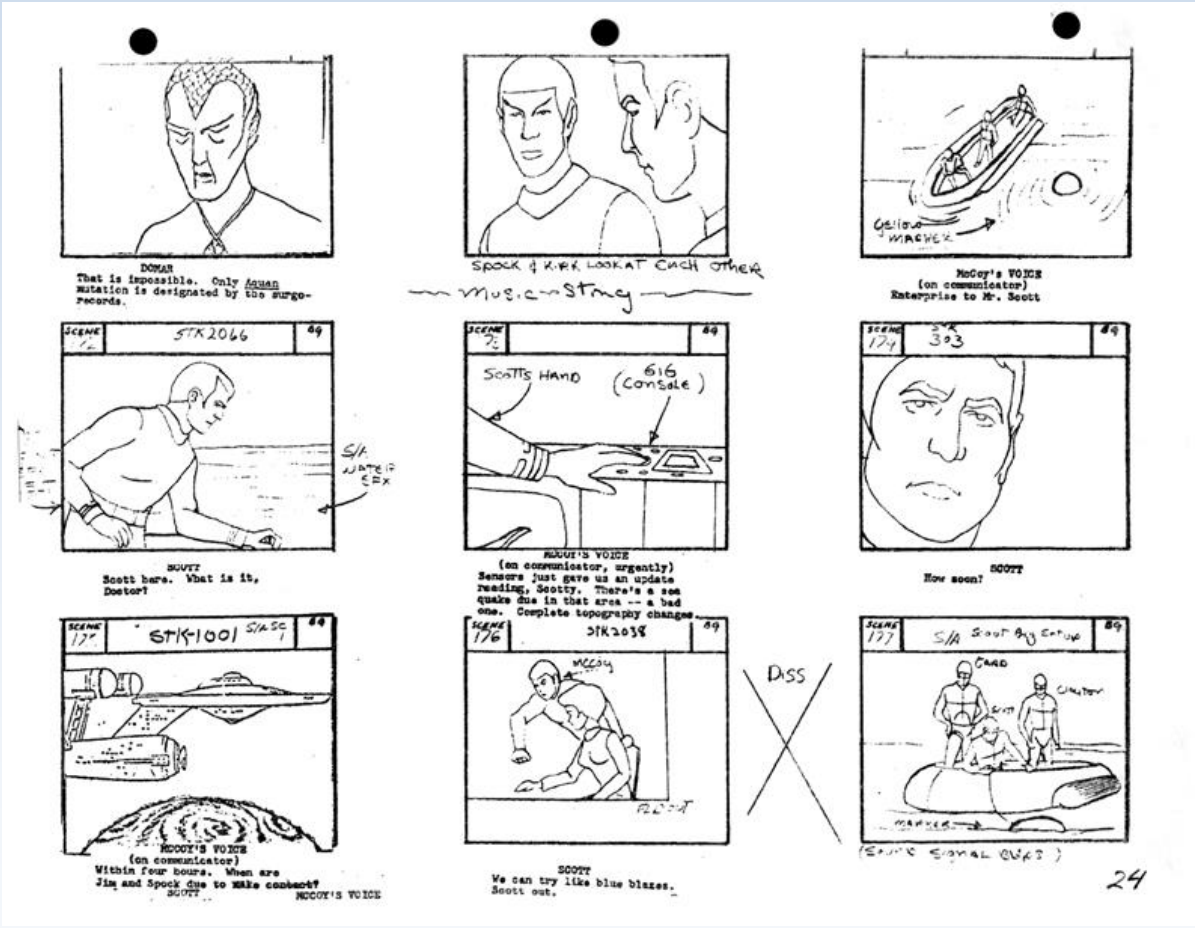
Intro to Animation: A Brief History

- You better know who this is…



Intro to Animation: A Brief History

- Storyboarding:
- Developed by Walt Disney



- http://www.danhausertrek.com/AnimatedSeries/Storyboard.gif

Intro to Animation: A Brief History

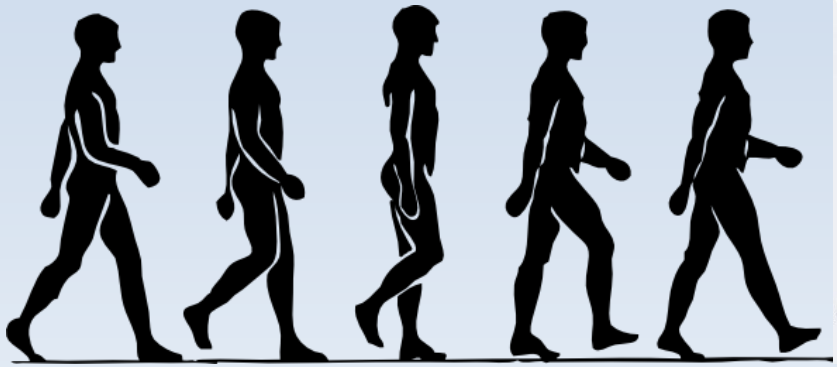
- Historical game animation:
- Early on, things were computer-assisted
- Traditional techniques turned into 2D Sprites
- Graphics hardware acceleration
- Fast Bit Blit (Bit Block Transfer BitBLT), display memory (destroys what is on screen already)
- Quickly rasterize rectangular regions on screen

Intro to Animation: A Brief History

- Historical game animation:
- http://rickdangerousflash.free.fr
- http://www.spaceinvaders.de
- http://www.smiliegames.com/galaga/
- http://www.thepcmanwebsite.com/media/pacman_flash/
- Muybridge's studies bring up a very important question…
- What does "*animation*" actually *mean*?

Locomotion vs. Animation

- First, “*locomotion*”



Locomotion vs. Animation

- Locomotion: simply put, *how things move*
- The actual *movement* of a creature or object is called *locomotion*
- This may be the way something walks, hops, rolls, flies, flails, gallops, what have you…

Locomotion vs. Animation

- Physically, locomotion describes the effort required for a being to move from one place to another
- Walking requires effort
- Flying requires effort
- Fighting against friction requires effort…
- What other definitions can you find???

Locomotion vs. Animation

- So what is "*animation*" then?
- If something is "*animate*" or "*inanimate*" what does that mean?
- Animate (adj.): showing signs of life
- Inanimate (adj.): not showing signs of life
- A tree is alive, but it is known as "*implicitly inanimate*" because it does not give us clear, visual *signs of life*!

Locomotion vs. Animation

- Definition of *animation* (in summary):
- A technique involving taking successive photographs of the state of some drawing or object to create ***the illusion of movement*** when the images are displayed in sequence.
- This sequence is also called a moving picture!
- Think about Muybridge!!!

Locomotion vs. Animation

- What is the fundamental difference between locomotion and animation???
- Locomotion is ***real life movement***!!!
- Animation is ***the illusion of motion and life***!!!
- Can think of animation as…
  a simulation of locomotion!
- *Continuous vs. Discrete* – which is which?

Locomotion vs. Animation

- Definition of *computer animation*:
- Animation using a computer.
- More specifically, image manipulation using a computer to produce sequences and the illusion of self-sustaining characters and objects! I.e. create moving pictures!!!

Locomotion vs. Animation

- ***Computer animation algorithms***:
- All 2D is still 3D… it's just data…
- Algorithms are general purpose… just math
- Minor differences between 2D and 3D algos.
- ***Computer animation techniques***:
- Similar and different between 2D and 3D
- We will discuss both!

The 12 Principles of Animation

- 12 fundamental principles of animation
- Developed by the traditionalists at Disney
- All related and interdependent
- Work together to help us make amazing sequences
- Animation as a whole is tough work!
- Use these as guidelines for creation!

Sprite Design Techniques

- The 12 Principles of Animation:
  - Timing
  - Easing (ease-in / ease-out)
  - Straight-Ahead vs. Pose-to-Pose (frames vs. keyframes)
  - Squash & Stretch
  - Solid Drawing
  - Anticipation
  - Exaggeration
  - Arc
  - Secondary Action
  - Follow-Through & Overlapping Action
  - Staging
  - Appeal (charisma)

The 12 Principles of Animation

- ***1: Timing***
- The *most important* principle by far!!!
- Remember: mathematically, animation is change over time
- We determine how things change over time…
- …how do we do this safely???

The 12 Principles of Animation

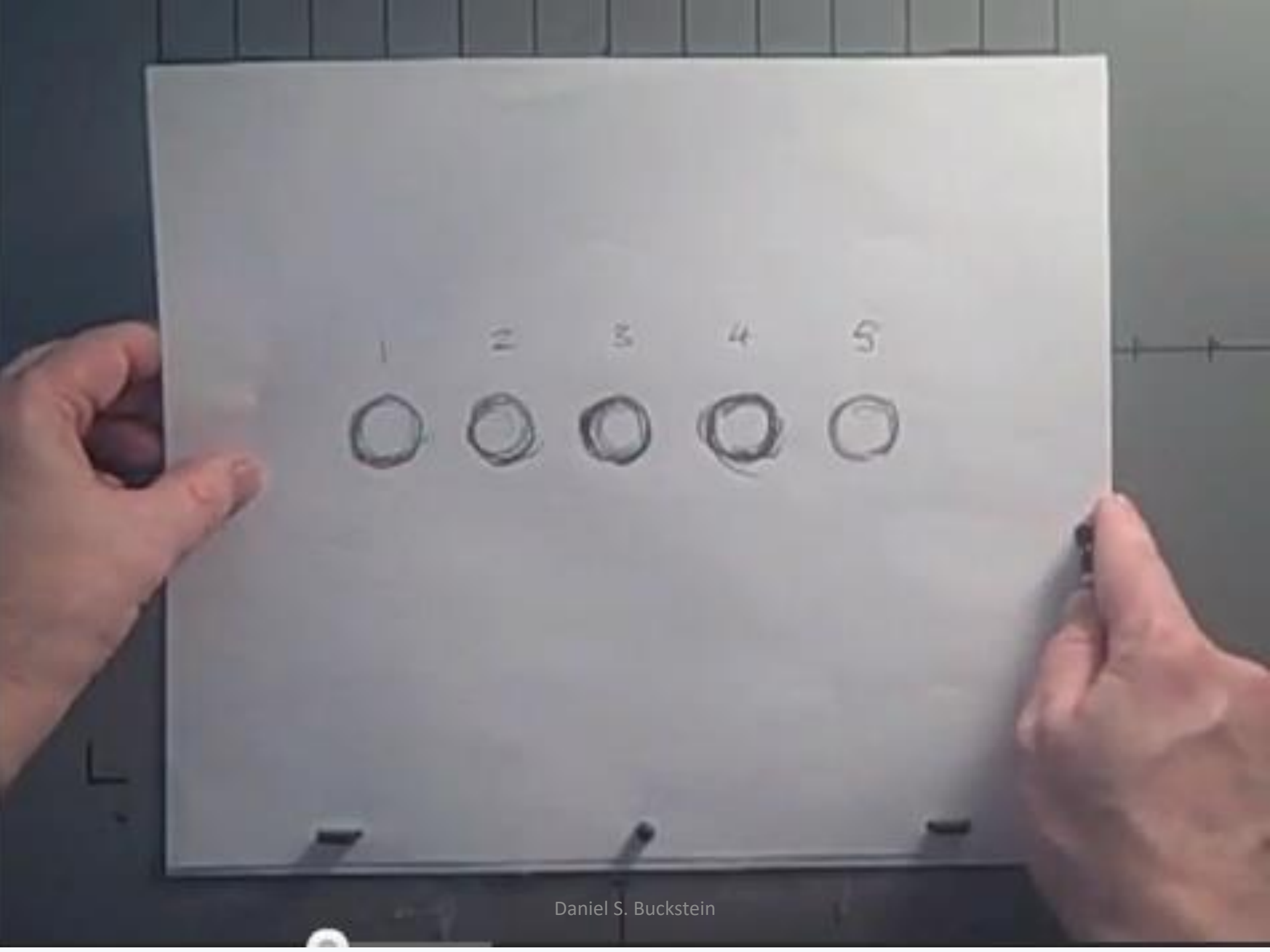
- ***1: Timing***
- Frame rate:

The 12 Principles of Animation

- ***1: Timing***
- Frame rate:
- Critical decision for the illusion of motion!
- …which is what animation fundamentally is!
- Film = 24fps (now entering the age of 48fps)
- Video = 30fps
- Games = ???fps

The 12 Principles of Animation

- ***1: Timing***
- Frame rate:
- Fun fact:
- Retina retains info for 1/10 (0.1) second
- Timing slower than that, or at greater intervals, results in…?
- Already see that with 15fps, see above video!



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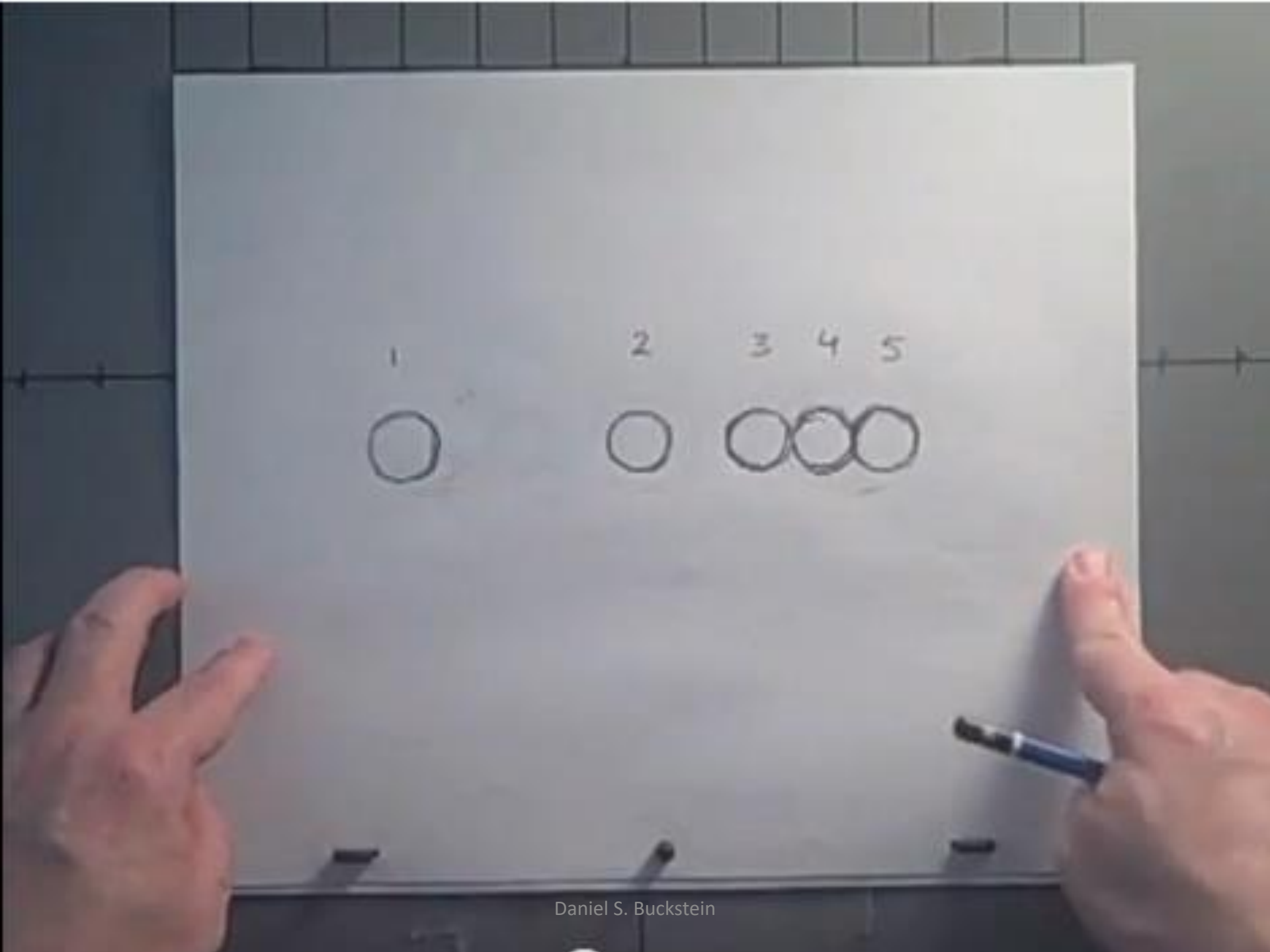

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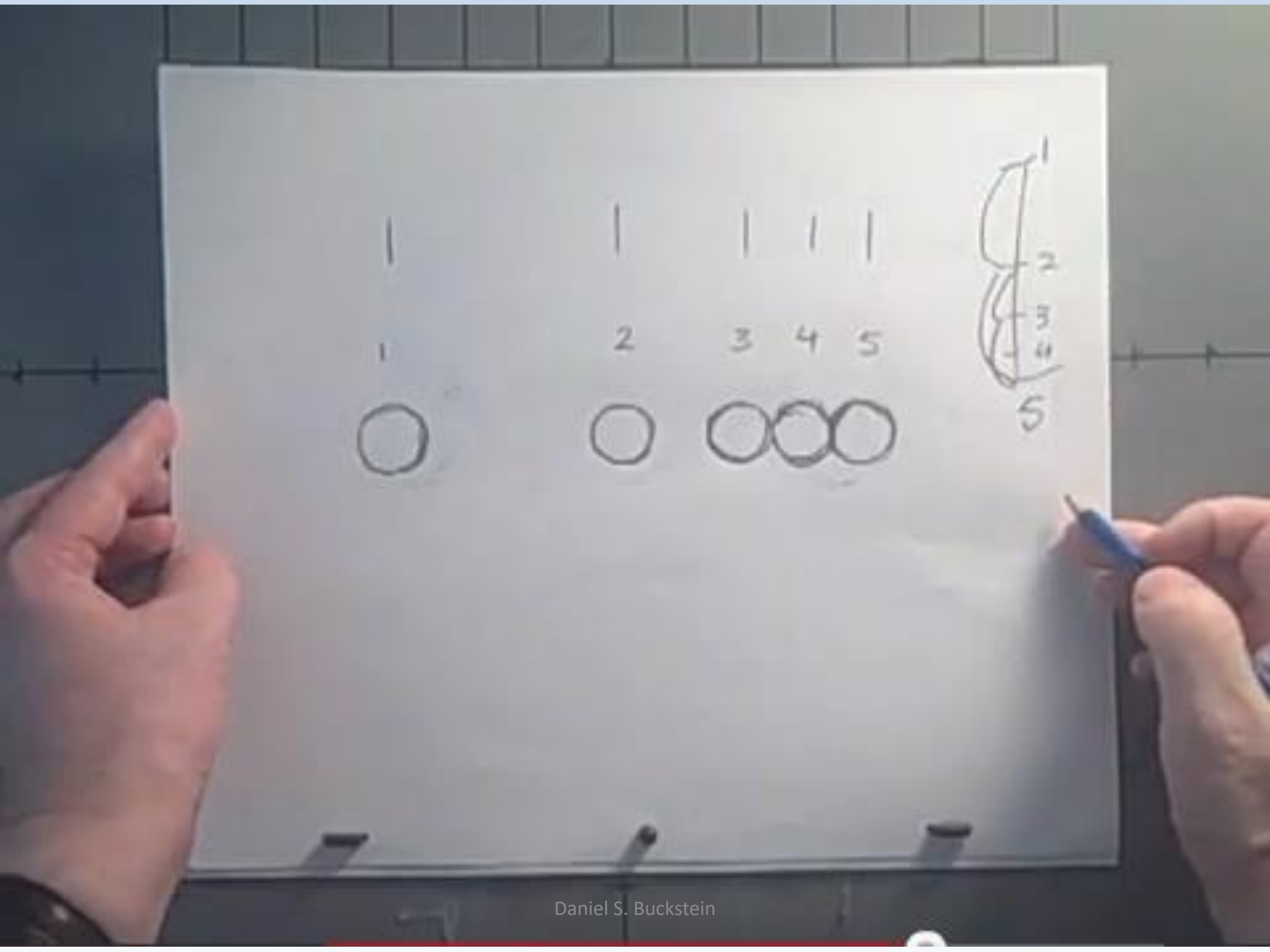
1
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1
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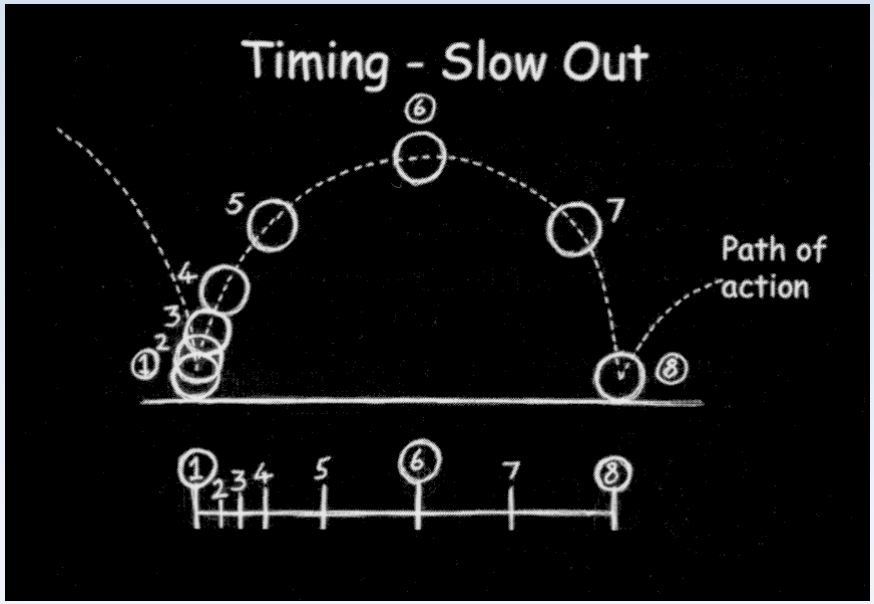
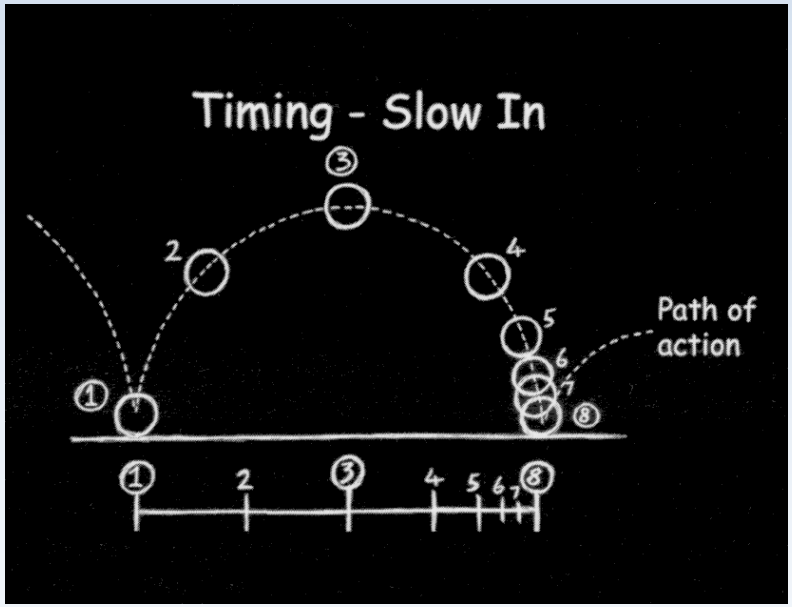
The 12 Principles of Animation

- ***2: Ease-in/Ease-out a.k.a. Slow-in/Slow-out***
- Builds on timing principle
- More drawings towards the beginning and end of an action to smooth it out
- Robotic parts change with constant speed…
- …but our characters should feel more lifelike!
- https://www.youtube.com/watch?v=fQBFsTqbKhY

The 12 Principles of Animation

- ***2: Ease-in/Ease-out a.k.a. Slow-in/Slow-out***





The 12 Principles of Animation

- ***2: Ease-in/Ease-out a.k.a. Slow-in/Slow-out***
- Use carefully to avoid smoothing actions that should be rigid

- Some things look awkward *with* the principle (i.e. used improperly)

- E.g. a bullet exiting the muzzle of the gun…

The 12 Principles of Animation

- ***3: Straight-ahead and Pose-to-pose***
- *Straight-ahead animation*:
- Also known as frame-by-frame
- Draw frame 1…
- Draw frame 2…
- Draw frame 3, 4, 5, …
- Type of animation that uses straight-ahead?

The 12 Principles of Animation

- ***3: Straight-ahead and Pose-to-pose***
- *Straight-ahead animation*:

The 12 Principles of Animation

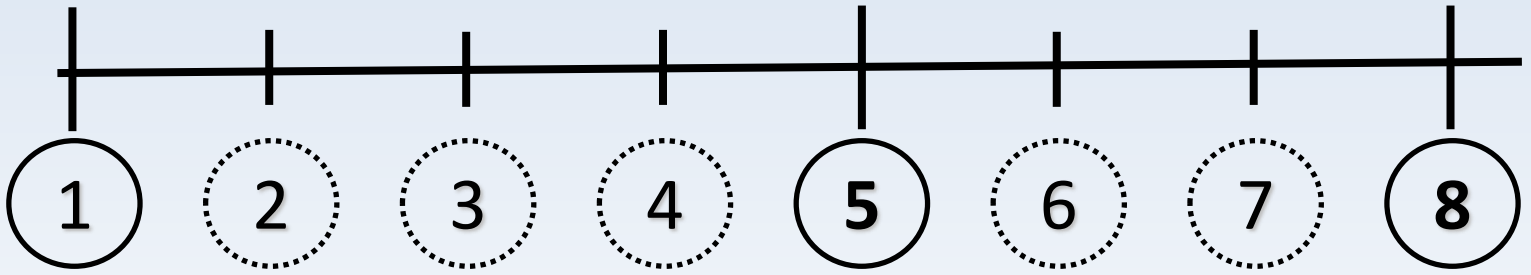
- ***3: Straight-ahead and Pose-to-pose***
- *Pose-to-pose animation*:
- Also known as keyframe animation
- Draw a “key” pose
- Set of frames that are important to the motion being animated
- Draw in-betweens later!!!

The 12 Principles of Animation

- ***3: Straight-ahead and Pose-to-pose***
- Keyframes vs. frames
- Keyframes are called so because…
- They are… “key” frames!
- Frames that are more important or denote some ***key*** moment or action in a sequence
- Normal frames are just in between keyframes

The 12 Principles of Animation

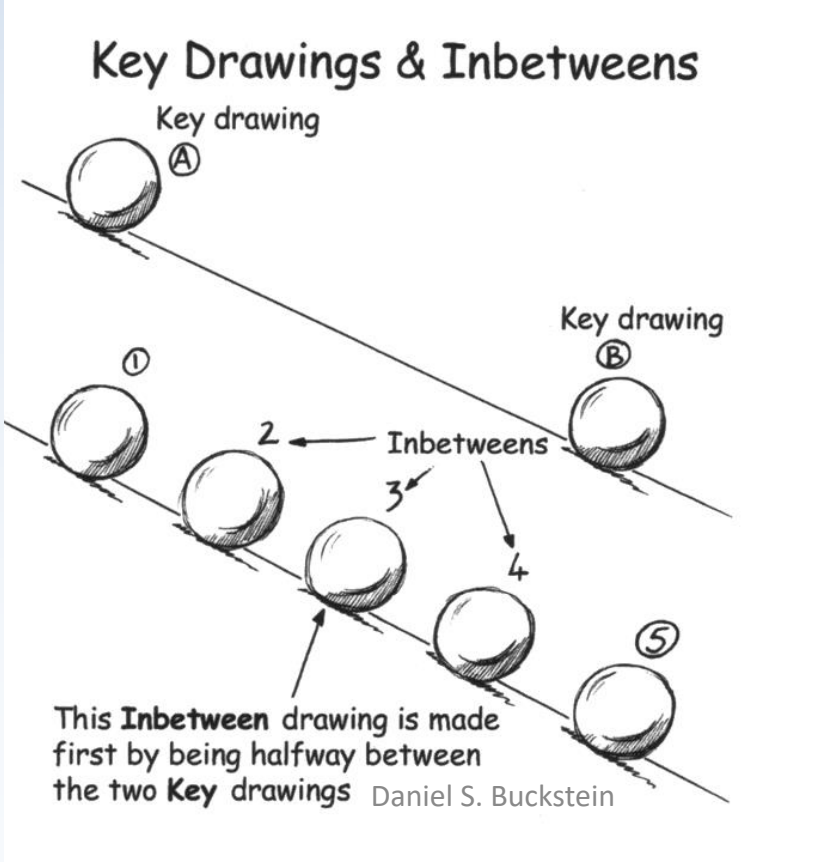
- ***3: Straight-ahead and Pose-to-pose***
- Keyframes vs. frames



- Storyboards are just a set of keyframes!

The 12 Principles of Animation

- ***3: Straight-ahead and Pose-to-pose***
- Keyframes vs. frames

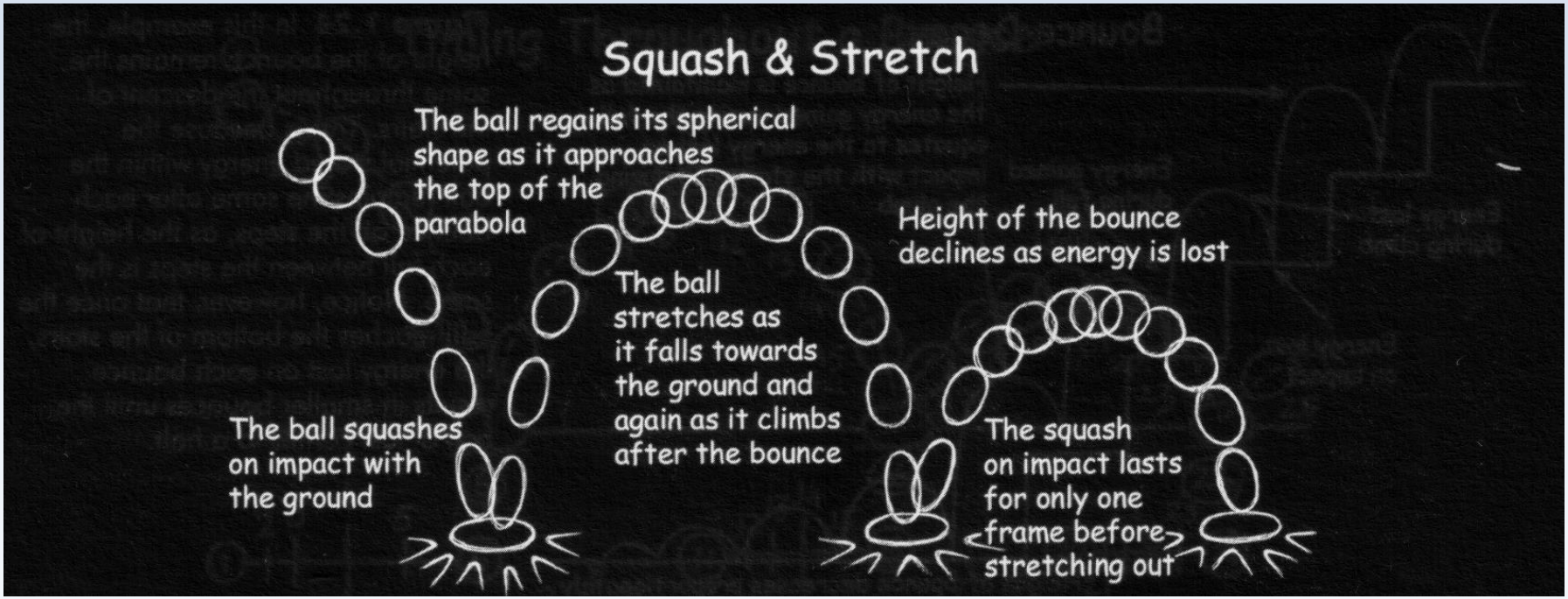


The 12 Principles of Animation

- ***3: Straight-ahead and Pose-to-pose***
- Keyframes vs. frames
- Computers are very good at this:
- Editor: specify property in frame 1
- Go to frame 100, specify new value for property
- Computer figures out in-betweens (next lecture)

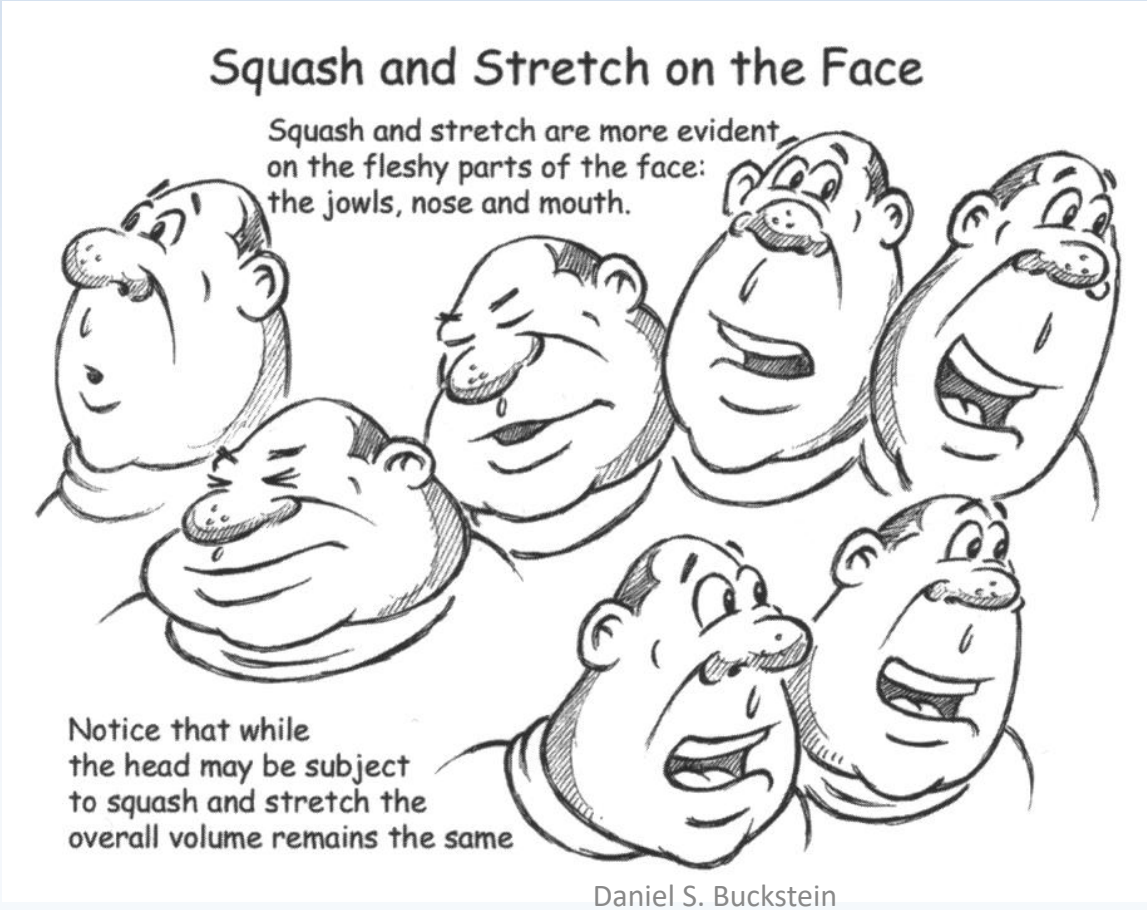
The 12 Principles of Animation

- ***4: Squash and Stretch***



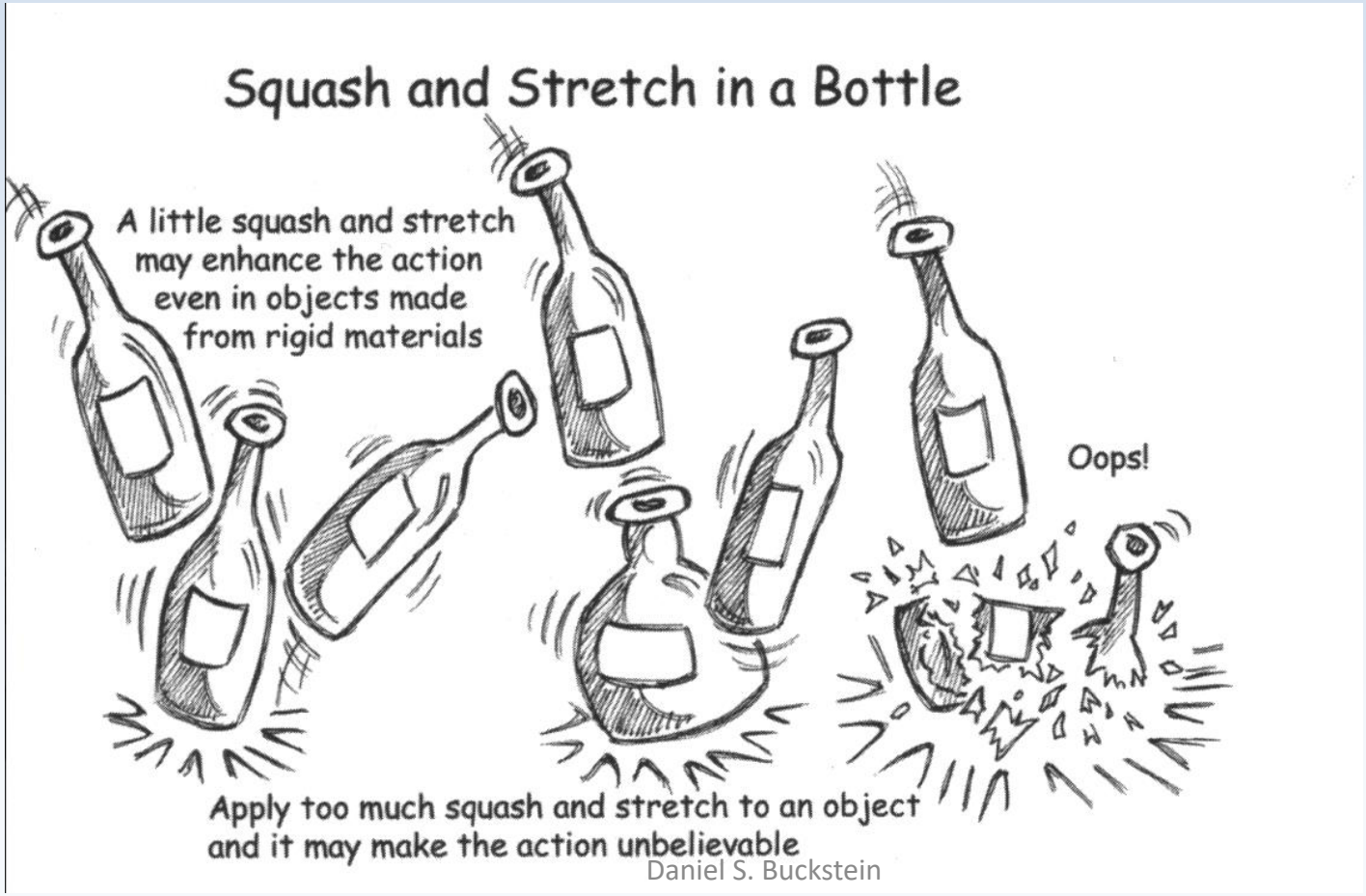
The 12 Principles of Animation

- ***4: Squash and Stretch***



The 12 Principles of Animation

- ***4: Squash and Stretch***



The 12 Principles of Animation

- ***4: Squash and Stretch***
- Pro tip: objects do not need to deform to achieve squash and stretch!
- Classic example:

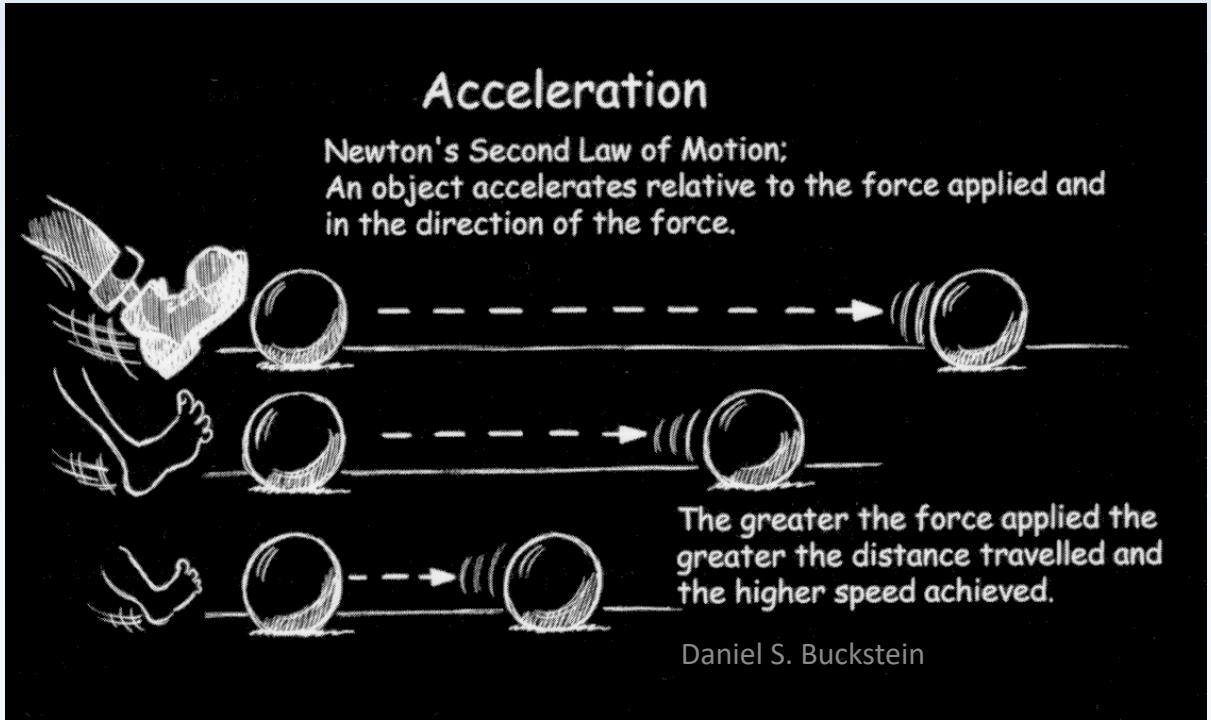
The 12 Principles of Animation

- ***4: Squash and Stretch***
- General rule:
- The volume of objects do not change!
- This makes the animation unrealistic!

- Which brings us to the next principle…

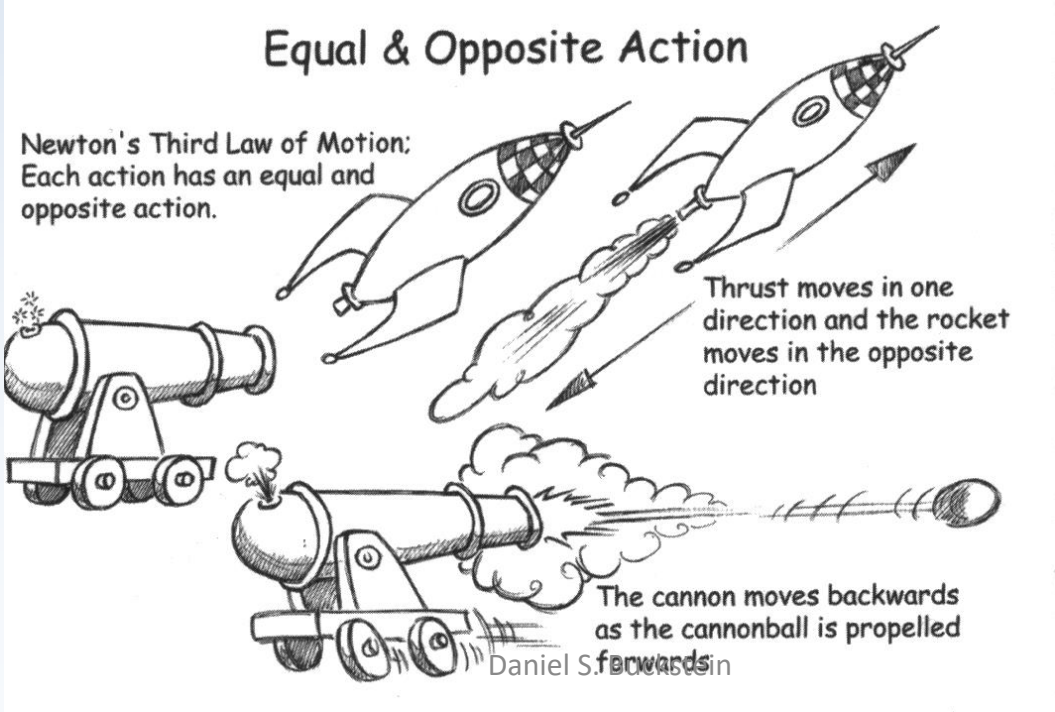
The 12 Principles of Animation

- ***5: Solid Drawing***
- Give objects realistic 3D properties
- Volume, weight, physics…



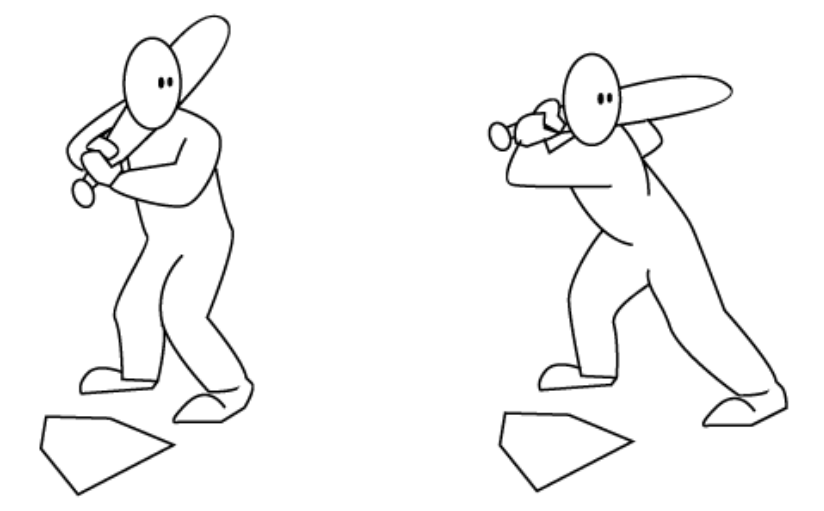
The 12 Principles of Animation

- ***5: Solid Drawing***
- Give objects realistic 3D properties
- Volume, weight, physics…



The 12 Principles of Animation

- ***6: Anticipation***
- Give clear indication that some action is about to begin…

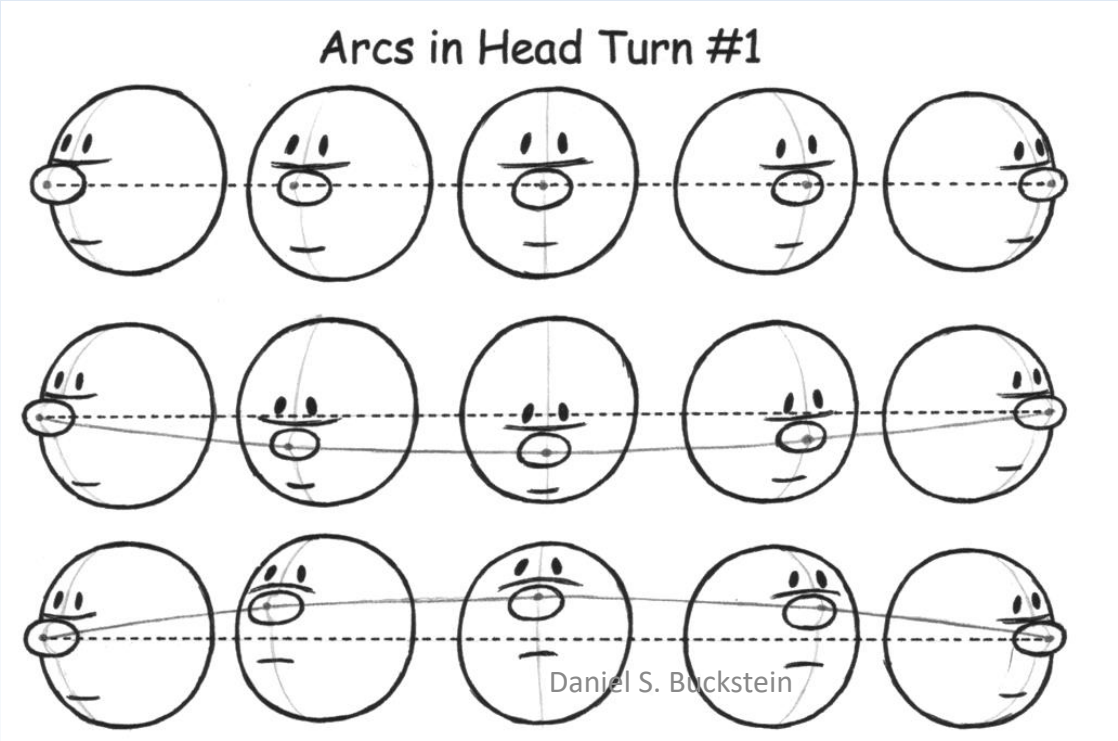


The 12 Principles of Animation

- ***7: Exaggeration***
- Overacting for dramatic effect

The 12 Principles of Animation

- ***8: Arc***
- Many actions and motions look a lot better when the change follows a curved path



The 12 Principles of Animation

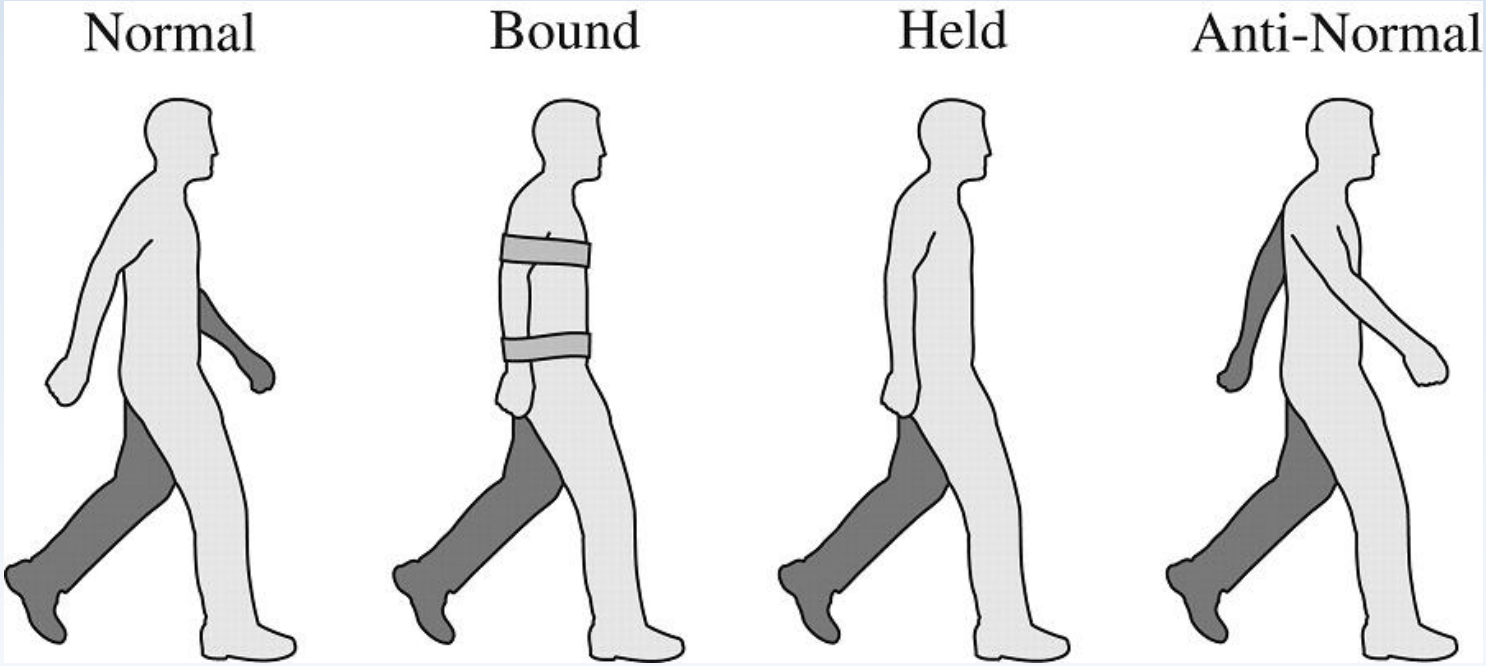
- ***9: Secondary Action***
- There is never just one thing happening during an animation sequence…
- The trick is to make multiple “sub-sequences” come together
- Some motions are offset in time
- Multiple related gestures happening simultaneously!!!

The 12 Principles of Animation

- ***9: Secondary Action***
- The primary action: main gesture or movement being done
- Secondary action: after primary action completed
- Secondary linked to primary, make a more believable and efficient movement

The 12 Principles of Animation

- ***9: Secondary Action***



The 12 Principles of Animation

- ***9: Secondary Action***
- Secondary action is a result of the primary action…
- *Tertiary action* is a result of the primary *and* secondary action
- Example of tertiary action?

The 12 Principles of Animation

- ***10: Follow-through and Overlapping Action***
- Arms move *independently* of the rest of the body, even though they are linked
- Even with secondary actions, all sequences and subsequences must be completed!
- The arm catches up after the body stops moving!

The 12 Principles of Animation

- ***11: Staging***
- Taking the stage, drawing attention
- An object demands direct attention from the audience

Can be done by a character's position, presence on the screen

The 12 Principles of Animation

- ***11: Staging***
- Taking the stage, drawing attention
- An object demands direct attention from the audience
- Can also be done with extrinsic factors…

…like a spotlight!

The 12 Principles of Animation

- ***12: Appeal***
- Charisma of a character
- Makes character feel real and interesting
- Makes us sympathize with the character

The 12 Principles of Animation

- Sum it up…

The 12 Principles of Animation

- By the way…
- The definition of “character” is not definite!
- A “character” can be anything:
- Human
- Mouse
- Rock
- Cube… whatever you want, just bring it to life!

Applications

- ANIMATION IS EVERYWHERE.
- Even in PowerPoint with us right now!
- Every time I click the mouse
- A thing that wasn't there before…

…just appears…

…or flies in from the bottom of the screen

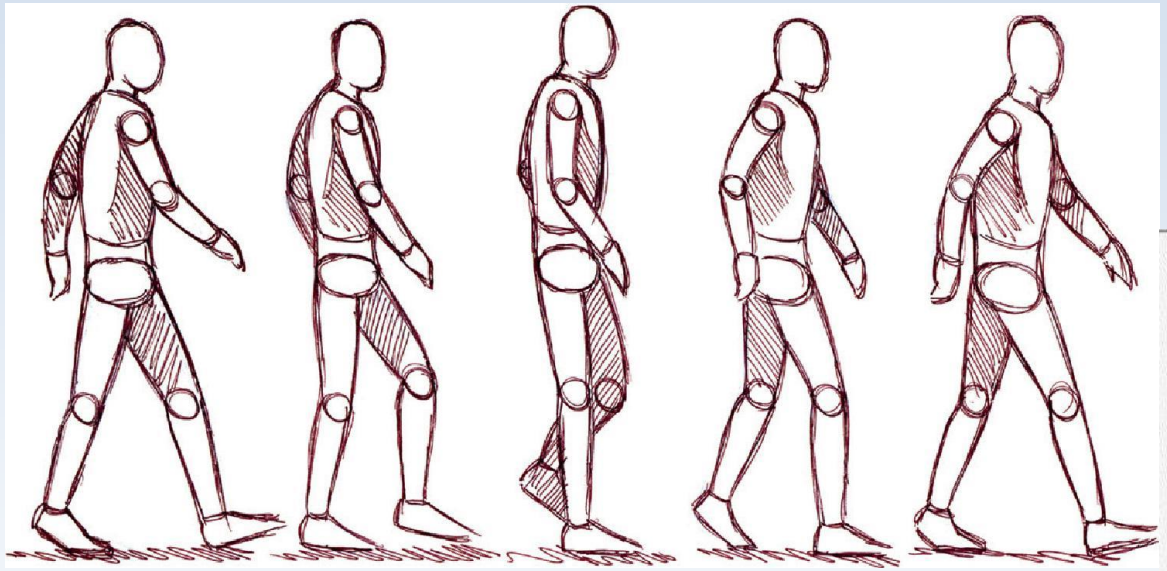
Applications

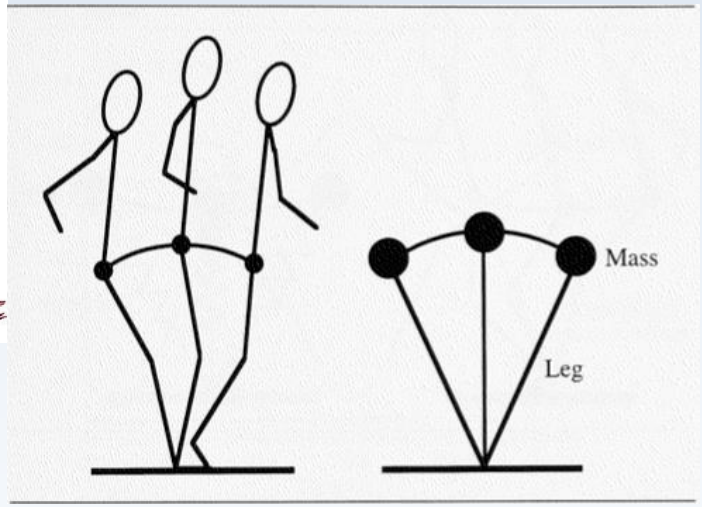
- A simple “change of state over time” is the fundamental behaviour of animation!

- If we can simulate something moving, it’s animation!

Applications

- Example: Walk cycle





- What else?

Applications

- “The Animation Show” by Don Herzfeldt
- https://www.youtube.com/watch?v=pMQ-t3nGzrI

- “Thought of You” by Ryan Woodward
- https://www.youtube.com/watch?v=OBk3ynRbtsw

- “La Faim (Hunger)” by Peter Foldès
- https://www.youtube.com/watch?v=vwU3UARE6yc

Applications

- Locomotion examples and problems:
- https://www.youtube.com/watch?v=W0F8JNs3sig
- http://www.youtube.com/watch?v=pG9NjGpGBh4

- Amazing sequences demonstrating the 12 principles:
- http://the12principles.tumblr.com/

The end.

- Questions? Comments? Concerns?