## Timing \& Scale

WHERE DISCOVERIES BEGIN

## Defining Size

Various ways to define size, such as volume, weight, etc.

For simplicity, we'll use length (or height).

For example,
Charming is $3 x$ the size of Puss.


## Gravity Timing

## Timing of motion due to gravity is a physical cue for size.

## Bowling ball is $x 4$ size of baseball and takes x2 time to fall comparable distance (one diameter).

For constant acceleration, the distance travelled goes as the square of the time elapsed.


## Timing and Scale

# Timing of a marble falling in slow-motion is similar to a bowling ball in real time. 

x4 Slow-Motion (120 fps) Normal (30 fps)

Ball Drop<br>Speed: 120 frames per second<br>Size: Marble ball - $3 / 4$ inch

www.AnimationPhysics.com

Ball Drop<br>Speed: 30 frames per second<br>Size: Bowling ball - 9 inches

www.AnimationPhysics.com

## Scale Models

Scale models filmed at $x 5$ normal will appear to be x25 times larger when they are destroyed by impact or explosion.


Apparent size goes as the square of the timing.

## Jason \& the Argonauts (1963)

Compare the sense of scale when running this scene at different playback speeds.

Normal Playback
x3 Playback


## Cadence

## Cadence (steps per minute) is a physical cue of size.

Timing of swinging pendulum is also gravity timing

Pendulum $x 4$ longer swings in $x 2$ the time regardless of angle.


## Walking Speed

## Walking speed is a physical cue for size.

Long legs swing more slowly than short legs but also have a longer step length.

Legs $\times 4$ longer have x2 walking speed since $x 4$ step length.


## Empire Strikes Back (1980)

Notice the timing of the giant walking tanks.

## Empire Strikes Back (1980)



In this same scene we see a two-legged walker (AT-ST) in the background. Just from the timing of its walk we know it's approximate size.

## Swinging and Tipping

Timing of motion for swinging or tipping over,

Timing scales with acceleration of gravity is also a physical cue for size.


Man is $4 x$ height of baby so he falls for $2 x$ the time

## Sequence 700 in Madagascar 3

Chain of monkeys and other characters is swinging under the plane as it weaves.


## Reference for Madagascar 3



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Reference was shot at x3 speed then digitally boosted to x6 speed.

The scale increases by a factor of x36 due to x6 slow motion timing.

Two foot chain swings like a chain of animals that's 72 feet long.

## Summary

- Timing of falling motion creates scale.
- Slowing the timing by a factor of 2 increases the scale by a factor of 4 ; slowing by 3 increases scale by 9 ; etc.
- Filming scale models with high-speed cameras uses this effect to make the models appear much larger.
- Giant characters have a slow walking cadence but fast walking speed due to the long legs.
- The same timing-scale relation applies to swinging and tipping motion.

