Jump Forces & Jump Landings

Jumping Action/Reaction

Jumping is done by pushing downward on the ground (action force) so the ground pushes upward on you (reaction force).

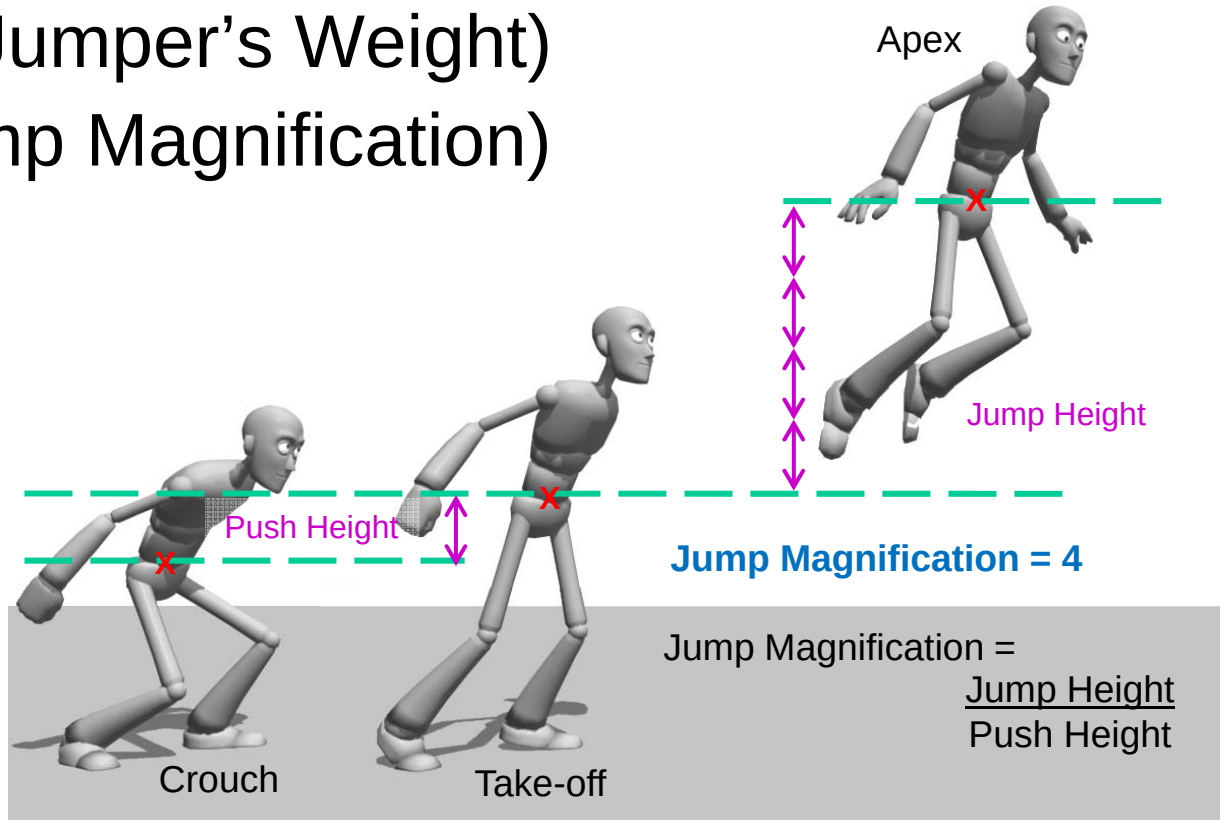
Height of the jump depends on the force and on distance over which you apply that force (push height).

Average Push Force

You can determine the average force exerted when jumping as:

(Jump Force) = (Jumper's Weight) x (Jump Magnification)

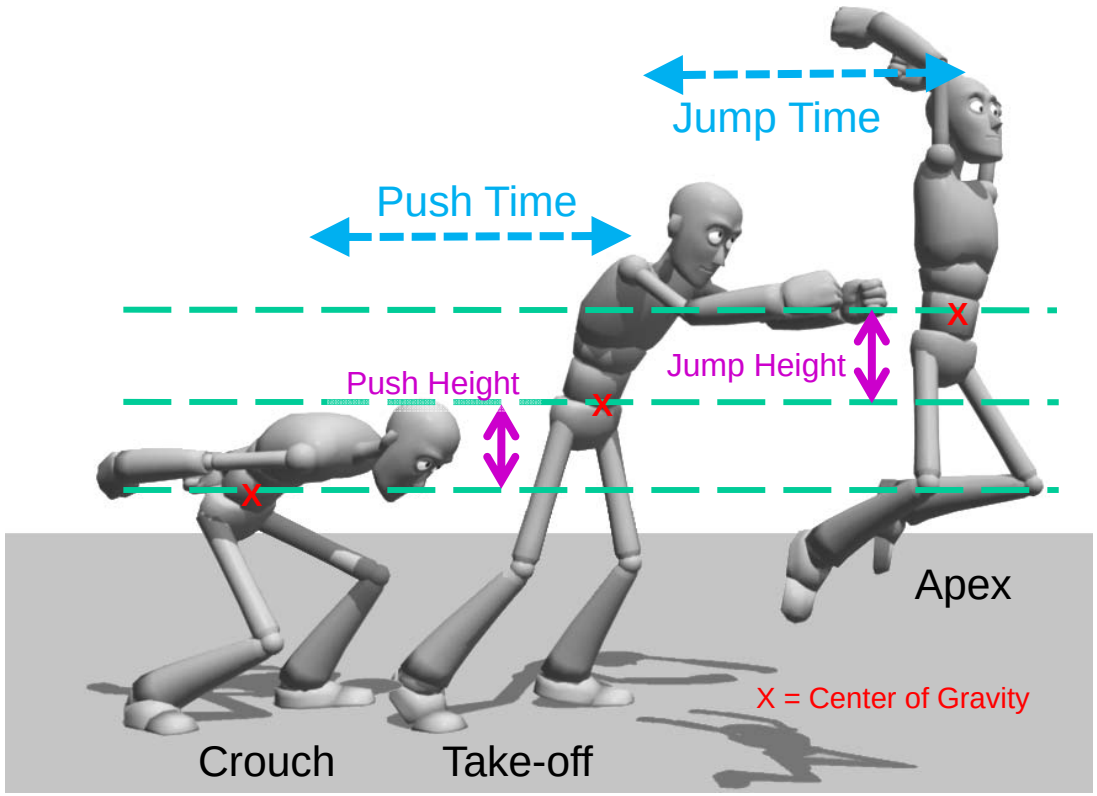
In this example a 200 lb. character exerts 800 lbs. of force to jump.



Timing the Push

$$\text{Push Time} = \frac{\text{Jump Time}}{\text{Jump Magnification}}$$

Remember that the jump magnification determines the push time.



Physical Strength and Timing

Physical strength of a character is reflected in the timing of the push, which is set by the jump magnification.

By Law of Acceleration, if the character pushes with a large force the acceleration is large so the push time is short.

Hancock (2008)

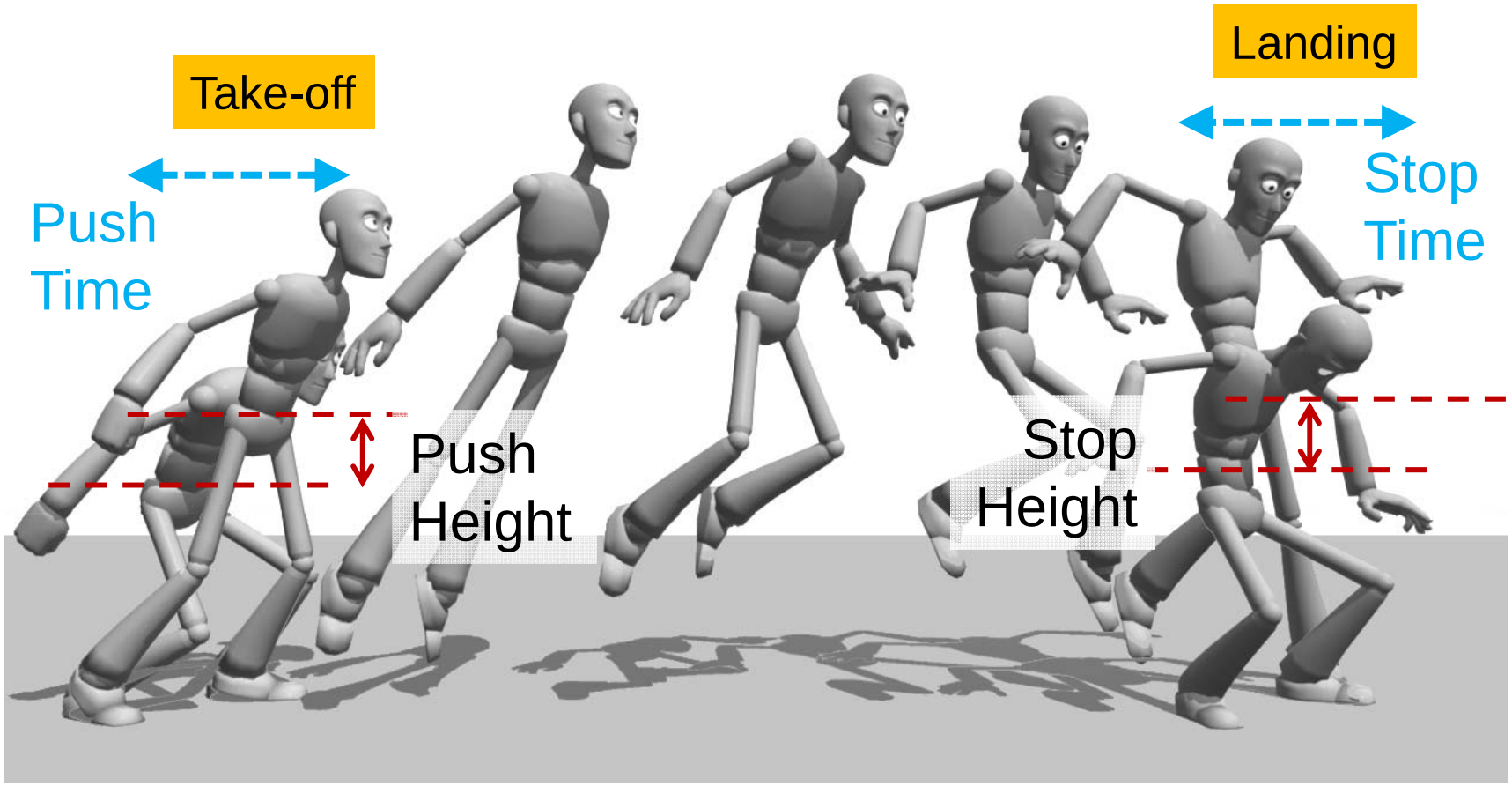
Hancock is a super-hero and when he jumps the force exerted on the ground is just as extreme on the take-off as it is on the landing.

Take-off

Landing

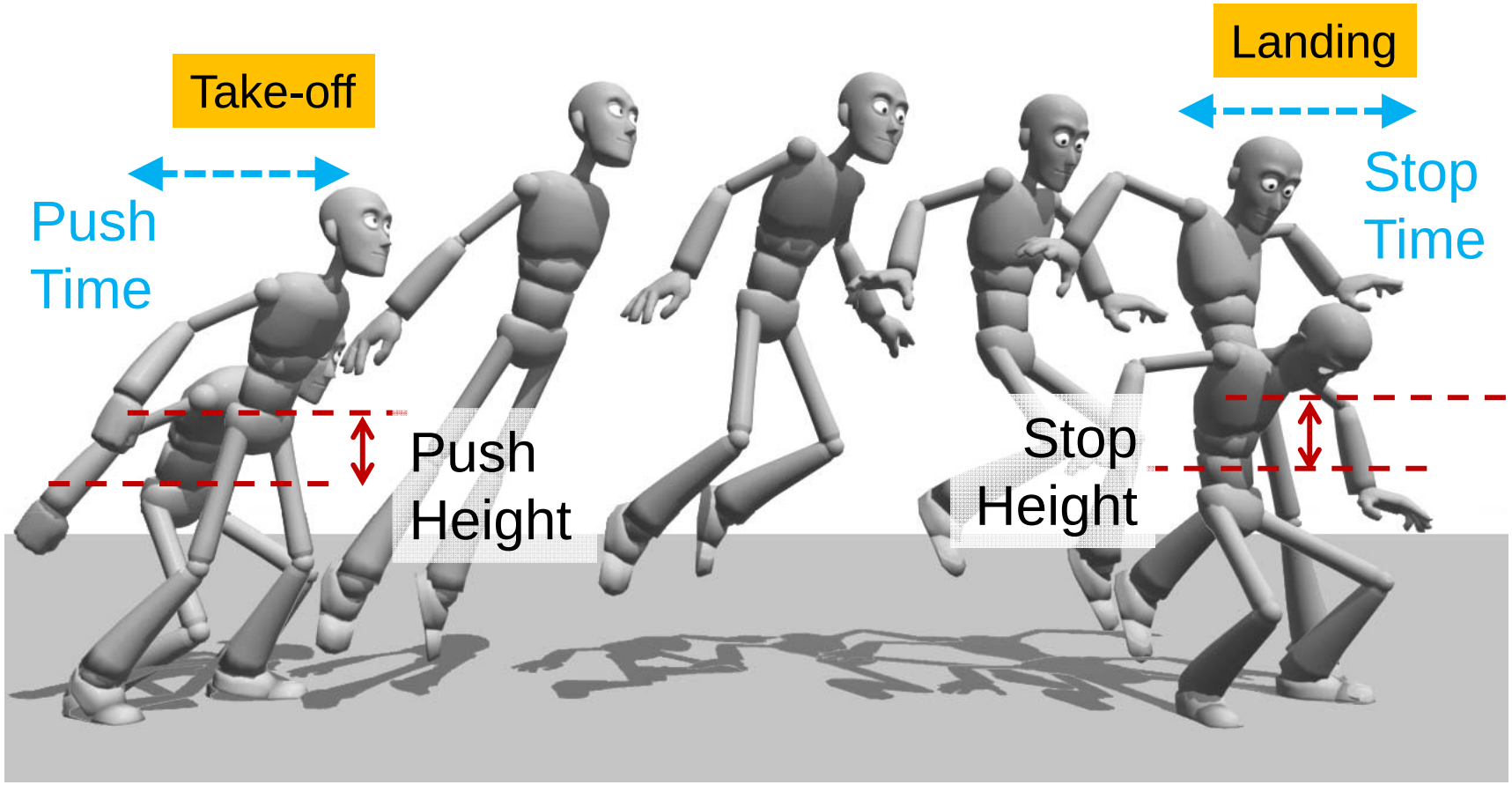
Timing the Landing

Landing of a jump is the reverse of the take-off.



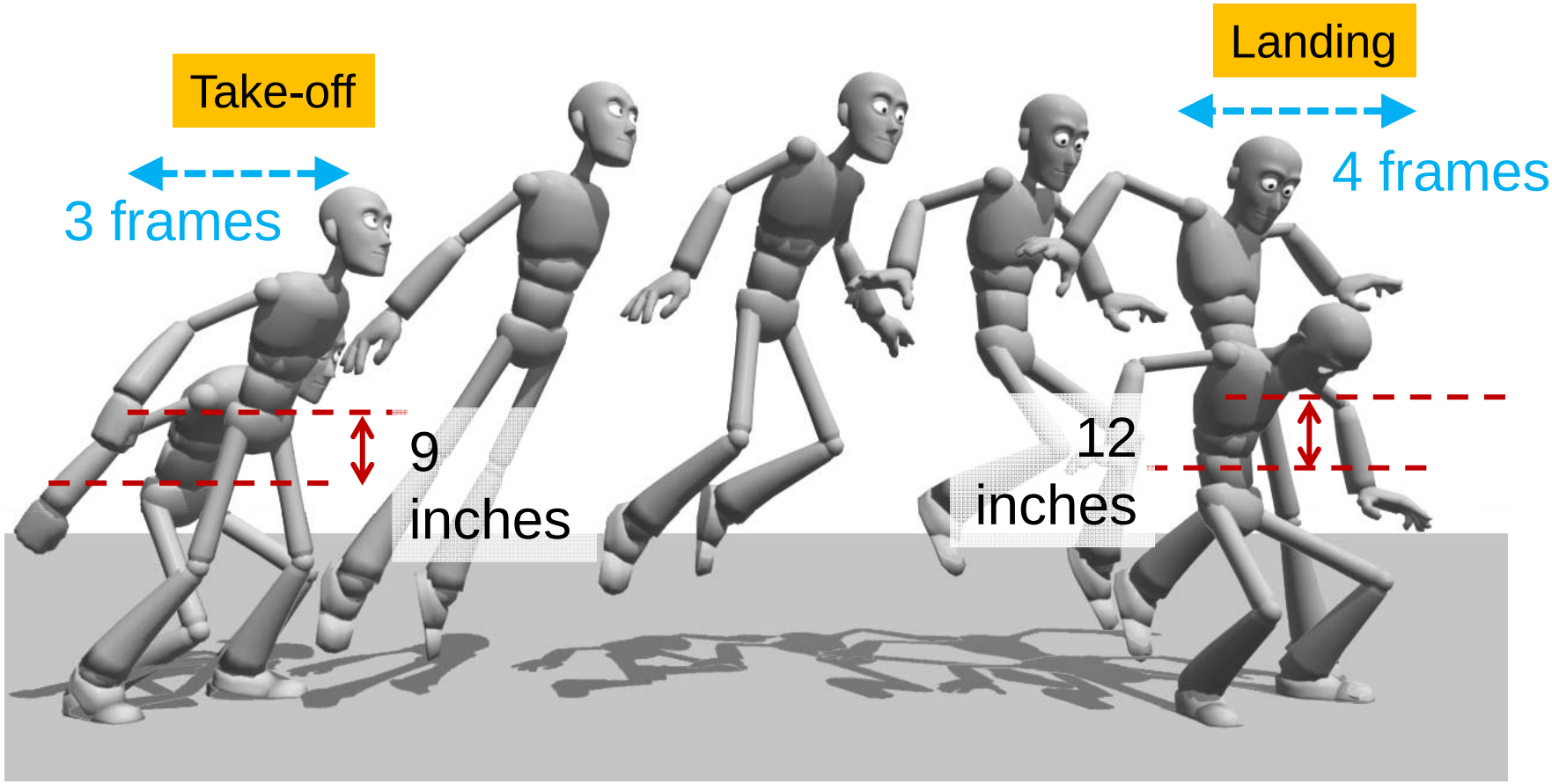
Timing the Landing

$$\text{Stop Time} = (\text{Push Time}) \times \frac{\text{Stop Height}}{\text{Push Height}}$$



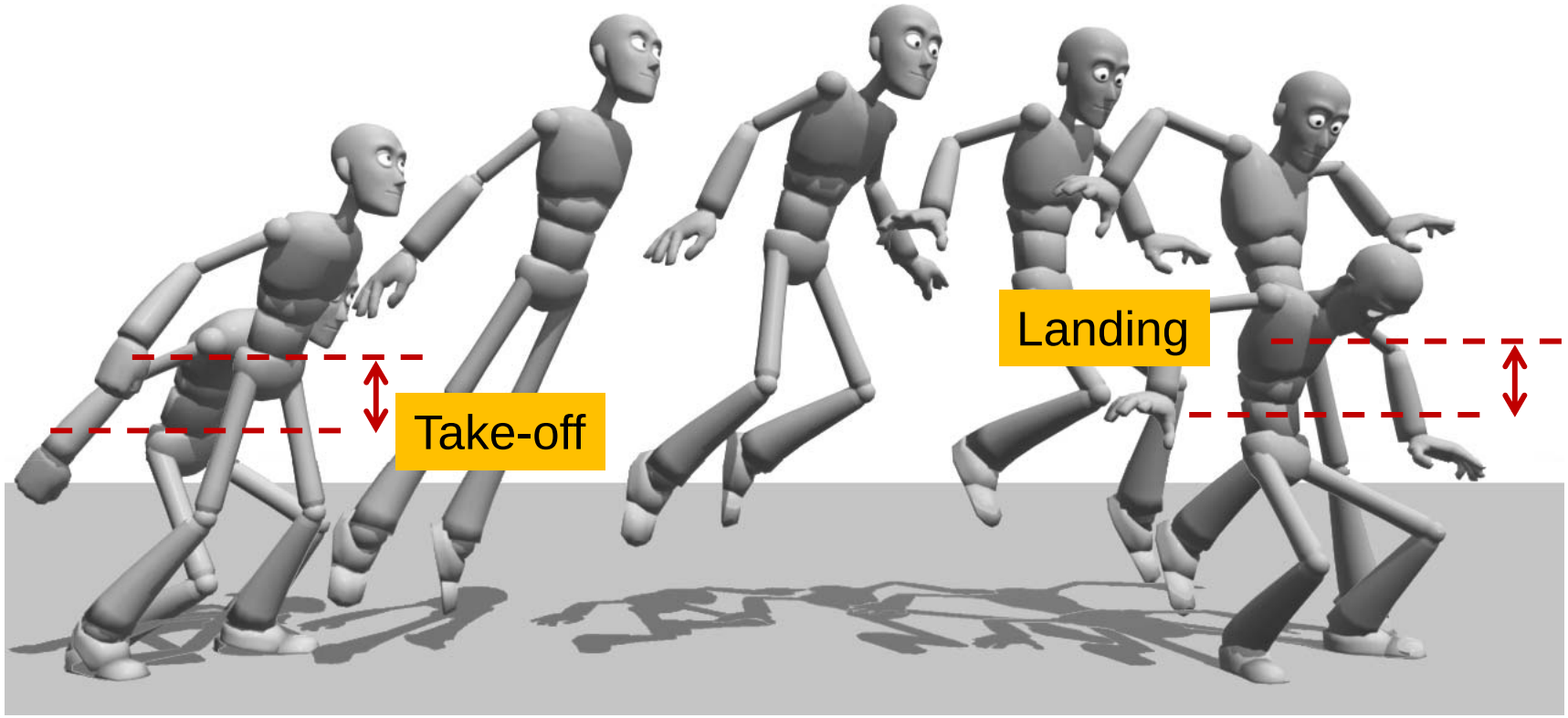
Timing the Landing Example

$$4 \text{ frames} = (3 \text{ frames}) \times \frac{12 \text{ inches}}{9 \text{ inches}}$$



Timing the Landing

If the crouch on landing is similar to the crouch when pushing off then the landing has similar timing to the take-off.



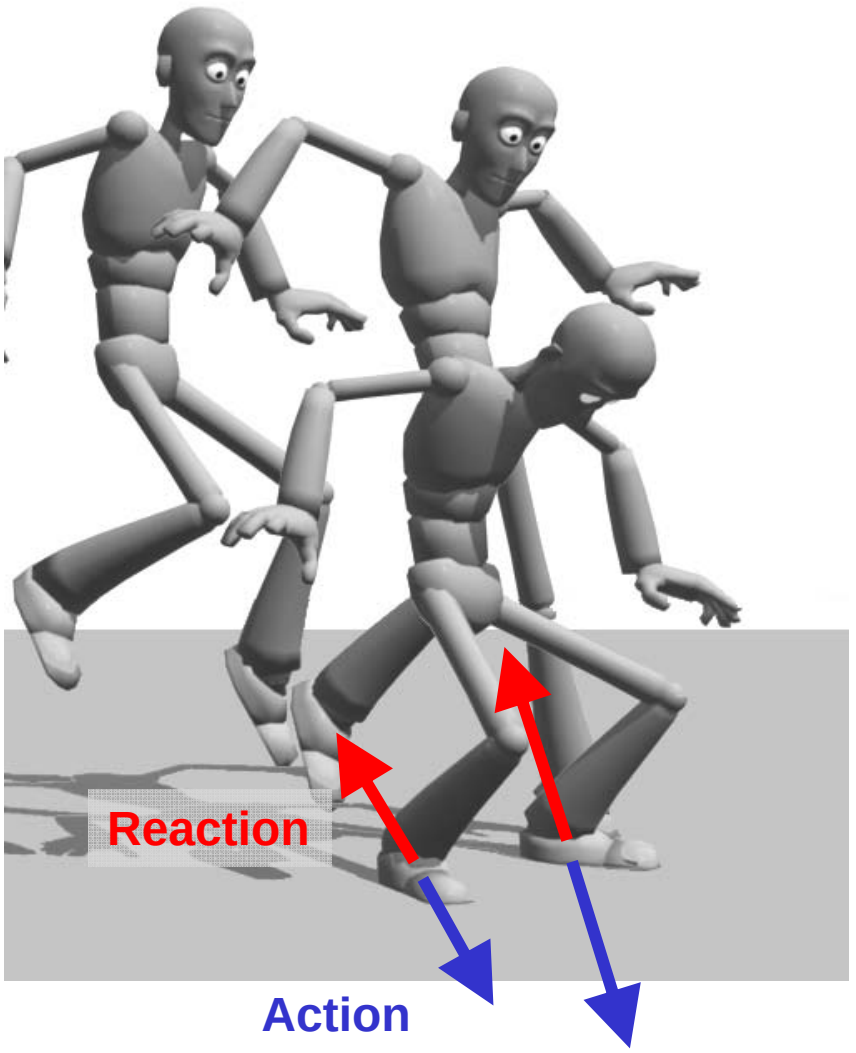
If the crouch on landing is shorter then the timing of the landing is shorter; if the crouch distance is longer, the timing is longer.

Forces when Landing

If the timing of the landing is similar to the timing of the take-off then the forces on landing are similar to the forces on take off.

If the landing has quicker timing then the forces are proportionally larger on the landing.

If the landing has slower timing than the take-off then the landing forces are smaller.



Landing in a Net

A flexible net minimizes the force of impact on landing by extending the time of impact.

By increasing the stop height, the net will increase the stop time.

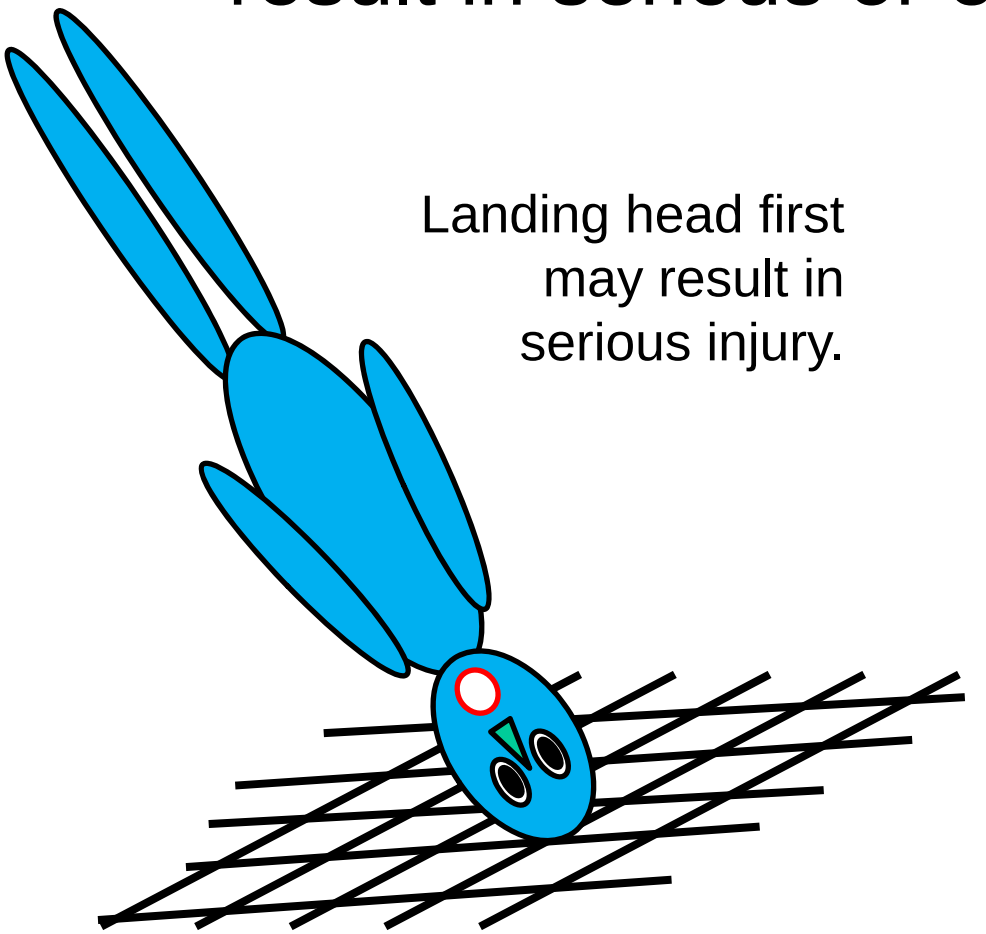
Turning into the Net

Human cannonball maneuvers to change her rotation so as to safely land on her back.

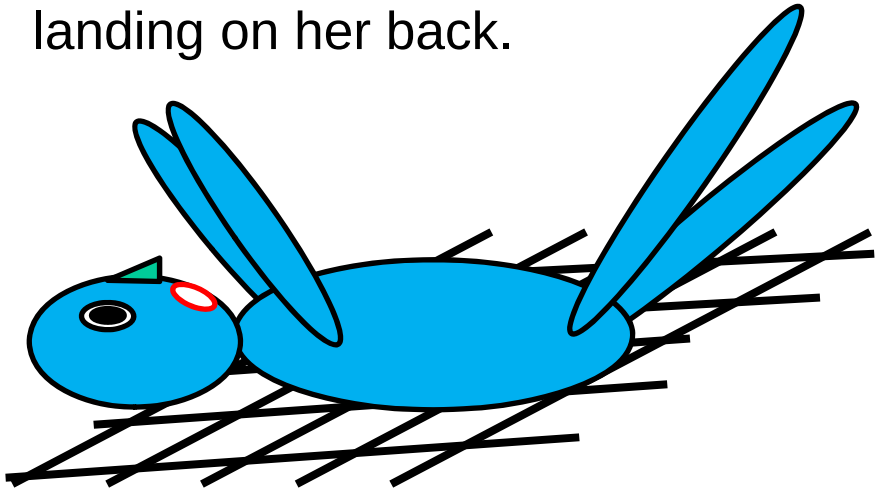
Human Limits for Landing

Landing in the net the wrong way can result in serious or even fatal injury.

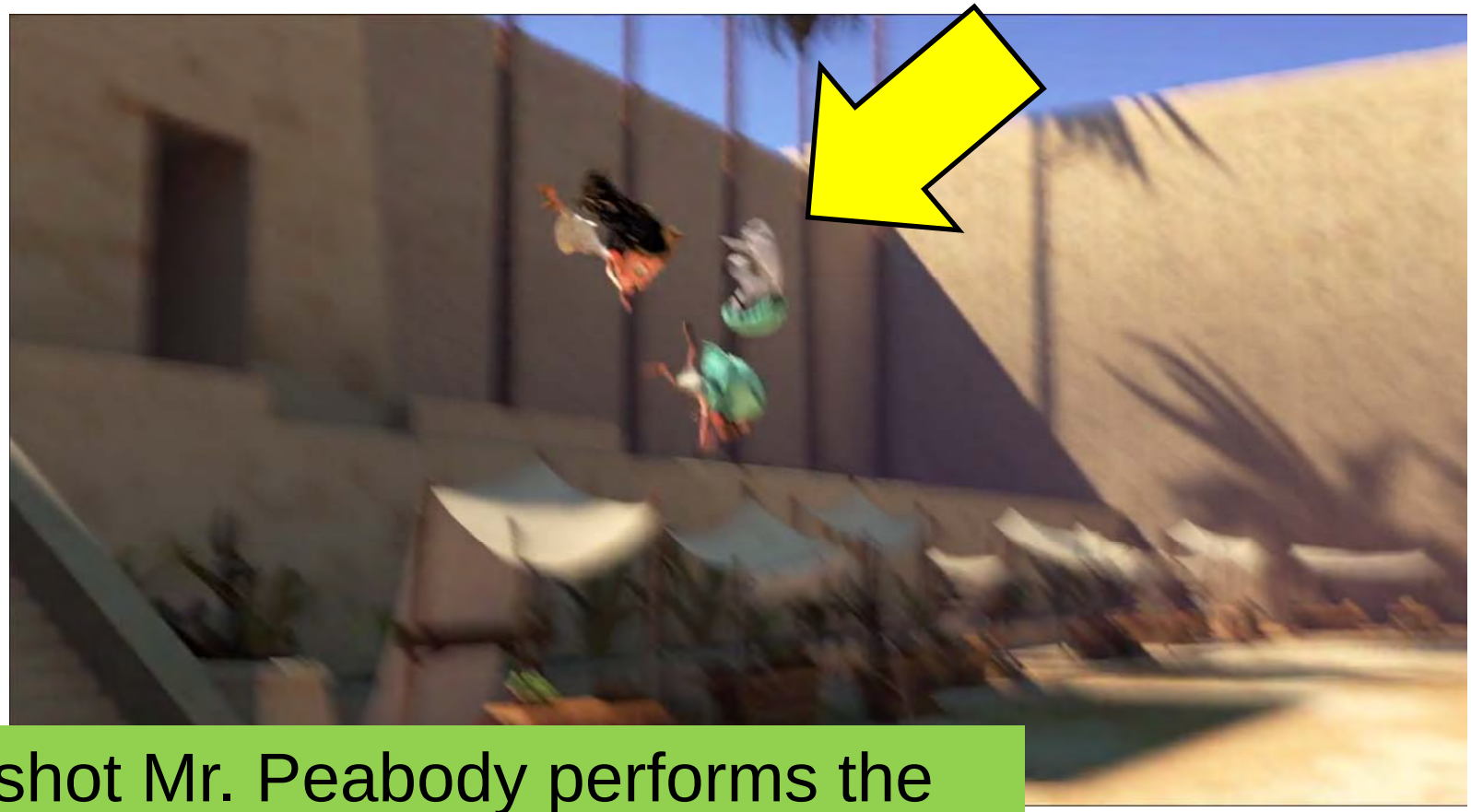
Landing head first may result in serious injury.



A performer can take over 20 gees of deceleration landing on her back.



Mr. Peabody & Sherman (2014)



In this shot Mr. Peabody performs the rotation maneuver to land on his back.


51:54
Mr. Peabody & Sherman

Summary

- Force exerted when jumping is the weight times the jump magnification.
- Physical strength of a character jumping is reflected in the timing of the jump.
- The landing is the reverse of the take-off.
- Timing of the landing is linked to timing of take-off and the stop/push height ratio.
- Force of impact on landing is reduced by extending the stop height.