Squash and Stretch - *mass and momentum.*

* Physical Principles

    * Essential Kinematics:
        * Newton's laws of motion.
        * Conservation of momentum.
        * Centrifugal forces; Velocity, Acceleration and Deceleration.

    * Effects of Gravity.
    * Centre of Gravity.
    * Potential and Kinetic Energy, Equilibrium of Forces.
    * Simple Physical Properties of Objects.
        * Mass, weight and density.
        * Elasticity.
        * Stress Distortion.

* Sensation and Experience of Motion and Force.

* The ball as a physical metaphor of movement.

* Animal Movement.

    ***Verb* - ANIMATION** ANIMATE: *(Webster's)* From Latin, animatus - invoke life, to make alive, to give life to, to stimulate to action or creative effort.

    ANIMATION: *"Animation is not the art of drawings that move, but the art of movements that are drawn"*

    - *Norman McLaren.*

Physical Principles

Essential Kinematics

Newton's Laws of Motion[1]

1. An object at rest or in motion tends to remain at rest, or in motion, in a straight line unless acted on by external forces.

2. A change in motion, or acceleration, is directly proportional to the force exerted on an object and inversely proportional to its mass.

3. To every action there is an equal and opposite reaction.

Displacement - is the position of a point relative to an origin.

Velocity - is the rate of change of displacement with respect to time.

***Acceleration* -** is the rate of change of velocity with respect to time.

Equations of motion:-

$v = u + at$

$s = ½ (u + v)t$

$v^2 = u^2 + 2as$

$s = ut + ½(at^2)$

Where:-

s	=	displacement (metres)
t	=	time (seconds)
u	=	initial velocity
v	=	velocity at time t ~ms1)
a	=	acceleration (ms)

* Velocity Curves Dealt with in Timing *also known as* function curves or motion graphs.

Conservation of Momentum

The total momentum of a system is constant in any direction provided no external force acts in that direction.

1. First described in Philosophiae naturalis principia mathematica, *published 1687*.

* No energy is lost if an object suddenly changes direction or comes to a halt. It must go somewhere,

* When we get on a bus, maybe climbing up the stairs,
* Perhaps on a train
* As the vehicle moves off we stagger backwards
* Our feet begin to more forwards first and the head and shoulder begin to move backwards.
* Its comes to a halt.
* Out feet slow down but the upper body moves forward

* Objects moving off,
* Small objects applying forces to heavier ones,
* Heavy objects hitting light one.

* Running on a slippery mat, we move forward, the mat flies backwards.

Centrifugal forces

* The bus turns a corner, we sway outwards, our body wants to continue on its straight

line course as the bus moves in a arc.

Effects of gravity

* Newton demonstrated that gravity is a force existing between two masses. It is directly proportional to their masses and inversely proportional to the square of the distance apart.

* What's that mean?

* The force of gravity is greater with very large objects.

i.e; Things are lighter on the moon (small) heavy on earth (big) and very heavy on Jupiter (really big).

* The further objects are apart the weaker the gravitational force between them.

Centre of Gravity

The ***centre of mass*** of a body is the point at which the mass of the body may be considered to be acting.

The ***centre of gravity*** of a body is the point through which the line of action of its weight acts.

The ***centroid*** of a body is at its geometric centre.

Potential and Kinetic Energy:-

* Systems are enabled to store energy.

* For example;
    * Compressing a spring.
    * Stretching an elastic band.
    * Bending a ruler.
    * Winding up a clockwork motor.
    * Lifting up an object.

* The system is prevented from releasing the energy, the kinetic energy, until a retraining force is removed.

Equilibrium of Forces.

Unstable Equilibrium

* When an object is balanced but is highly unstable. A small movement will result in it falling over.

Stable Equilibrium

* A small movement will not over balance the object but a large force will.

Neutral Equilibrium

* Lowest level of entropy Cannot be unbalanced this is the lowest level.

Distance of centre of gravity to the ground.

Simple Physical Properties of Objects

Mass and Weight

Mass is a measure of the amount of matter contained in a body.

* A massive body will need a larger force to change its motion. The mass of a body may be considered constant, whatever the position of the body, provided that none of the body is destroyed or damaged.

The ***weight*** of a body is the force with which the earth attracts it.

* Weight is dependent upon the body's distance from the earth, so a body *"weighs"* less

at the top of Mt. Everest than it does at sea level.

Elasticity

* Elongation of an object when forces applied.

    * Rubber band, springs, elastic,

Hooke's Law

$$T = \frac{\lambda x}{l}$$

Where

T tension in the rubber or spring.
λ modulus of elasticity.
l unstretched length.
x extension.

The ball as a physical metaphor of movement.

Bouncing Balls

* Variation in materials
* ***Billiard*** Ball - Very hard, solid, Totally inelastic, transfers its energy
* ***Squash*** Ball - Easily compressed and hollow, Highly elastic, conserves its energy

* ***Plastacine*** Ball -Malleable, Extremely elastic, most energy consumed in distorting the object.
* ***Water droplets*** -Fluid, Totally elastic, almost all of the energy conserved, droplet shatters.

* All of the balls in motion are similar, the more flexible balls upon analysis appear more energetic, more lively.

Density

* This is the quantity of mass per unit volume.

Real objects.

* Not homogeneous. They are not made simply of one substance.

* House brick,
* Ice cube,
* Glass marble,
* Wooden stick.

Composite

* Made of a mixture of materials, different desisted and different masses.

* Living creatures articulated. They are flexible, have joint and centres of movement.

Animal Movement

* When animals run they become pensive then explode, they appear to compress, squash themselves up like a squeeze box or concertina or like a spring tensed ready to burst forth.

* Examine running cycle of dog and cat.

* Examine segment from a Disney classic for instance “Jungle Book”.

Concluding Remarks

Animation is aesthetic, its not possible to create a simple set of "rules" to work to. Effects developed for the expression of some categories of motion may also lend themselves to others. Squash and stretch discussed here are related to physical movement this technique undoubtedly enlivens other wise dull movement and the character or motion is a lot more supple and natural. Living creatures have free-will and emotive drives which are the prime force acting upon their movement. Inevitably therefore, Squash and stretch can be used, as we will see later to develop emotion.