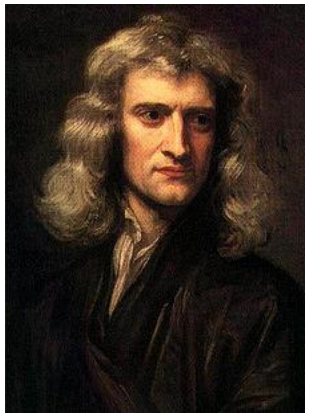
Biomechanical Principles and Applications



Some Important Terms

- **Equilibrium:** a 'perfect' situation where more than one force acts on a body but, because the sum of forces is zero, no change in velocity (speed) results; balance
- **Conservation of Energy:** the principle that states that energy can neither be created or destroyed, it can only be converted from one form to another
- **Centre of Mass:** the point at which the mass of a body is focused

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- **Acceleration:** a change in velocity (speed)
- **Force as a Vector:** a push or pull of a certain magnitude in a particular direction
- **Angular Acceleration:** aka rotational acceleration is the change in angular velocity that a spinning object undergoes per unit time
- **Moment of Force (Torque):** in comparison the linear motion, in rotational motion, the object in question spins around an axis. Instead of force, there is what is known as the moment of force (torque) which causes rotation

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- **Moment of Inertia:** In rotational systems, the moment of inertia depends on the distribution of the mass in relation to the axis of rotation. The further the mass is from the axis, the greater the moment of inertia. The closer it is to the axis of rotation, the easier it is to rotate it or to stop it from rotating.

Sir Isaac Newton's Laws of Motion

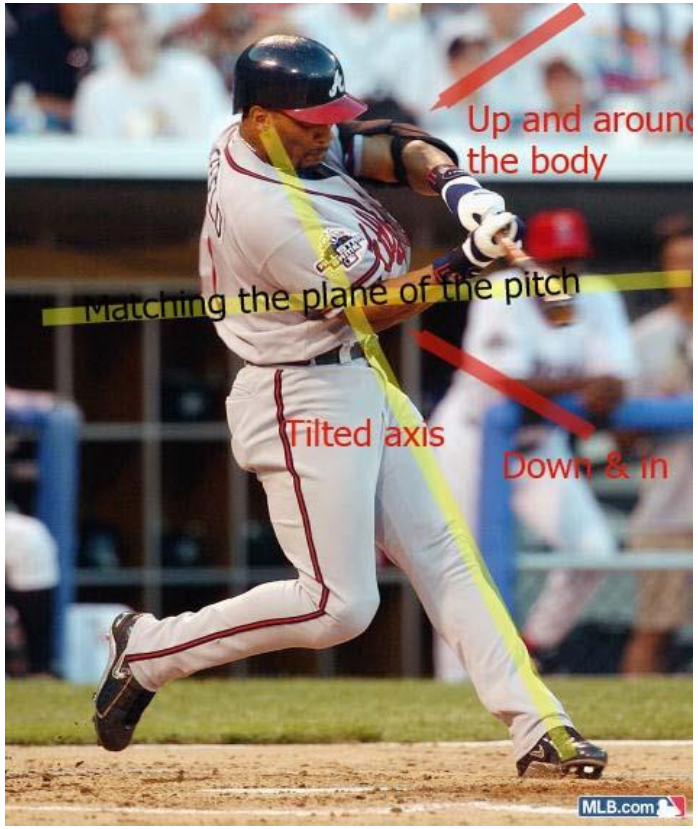
- Newton's theory and biomechanics rests on two assumptions:
  - Physical equilibrium (First Law)
  - Conservation of energy (Thrid Law)
- Newton's First Law: The Law of Inertia
  - Every object in a state of motion tends to remain in that state unless an external force is applied to it
- Newton's Third Law: The Law of Reaction
  - For every action there is an equal and opposite reaction

Equilibrium

- Normally, a force acting on a body results in acceleration
- **Equilibrium** – a 'perfect' situation where more than one force acts on a body but, because the sum of forces is zero, no change in velocity (speed) results
- Equal balance between forces

The Conservation of Energy

- Energy can never by created or destroyed
- It can only be converted from one form to another



Types of Motion

- 2 types of motion
- **Linear (or translational) motion**: movement in a particular direction, i.e. 100M sprint. Force is generated by an athletes muscle and the result is motion in a straight line
- **Rotational motion**: movement around an axis
  - Force is applied off-centre causing rotation
  - i.e. Kick a soccer ball through its centre of mass and it will go straight. Kick it “off-centre” and the ball will rotate

Linear Motion

- Running in a straight line requires **acceleration:** a change in velocity – speeding up
- When you change direction while running a **force as a vector** is introduced – a push or pull in a particular direction
- http://www.youtube.com/watch?v=S-24tzoRAcQ

Rotational Motion

Same principles apply as in linear motion

Instead of acceleration there is **angular acceleration**

The **moment of force (torque)** provides the force to cause rotation

The **moment of inertia** refers to the resistance to rotation

- The rotating object will be unmoved providing there is no additional moment of force that would cause an angular acceleration

Some Examples of Rotational Motion

- http://www.youtube.com/watch?v=AQLtcEAG9v0
- The figure skater begins to spin with her arms and a leg spread apart then brings them closer to the body. This results in an increase in angular velocity
- http://www.youtube.com/watch?v=ec_Nl-zY-uM
- As the divers open up before entry into the water, the moment of inertia increases which slows down their angular velocity