ANALYSIS OF THROW AND PUSH PATTERNS

Push-and-Pull Motions

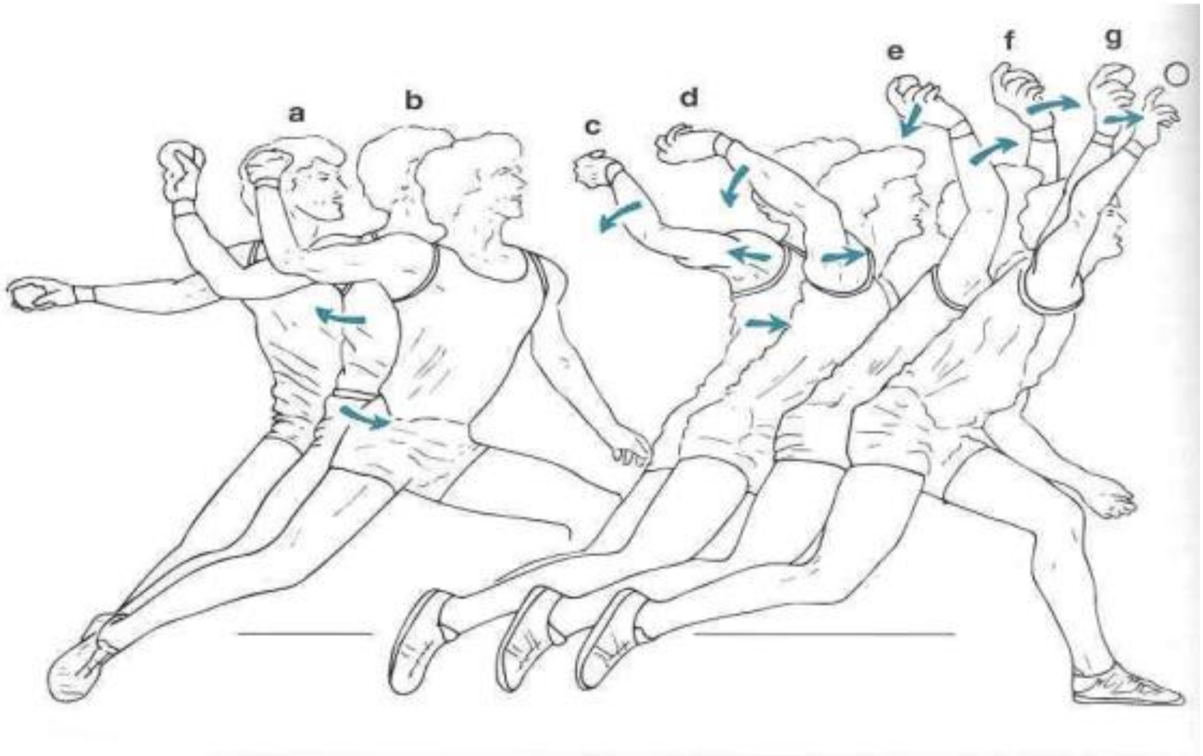
Definition : a segment motion that involves moving an object, either directly by part of the body or by means of implement, in pushing and pulling pattern

- a pitcher throws a baseball
- a tennis player serves a tennis
- a worker lifts a box from the floor onto an overhead rack
- an archer shoots an arrow from a bow

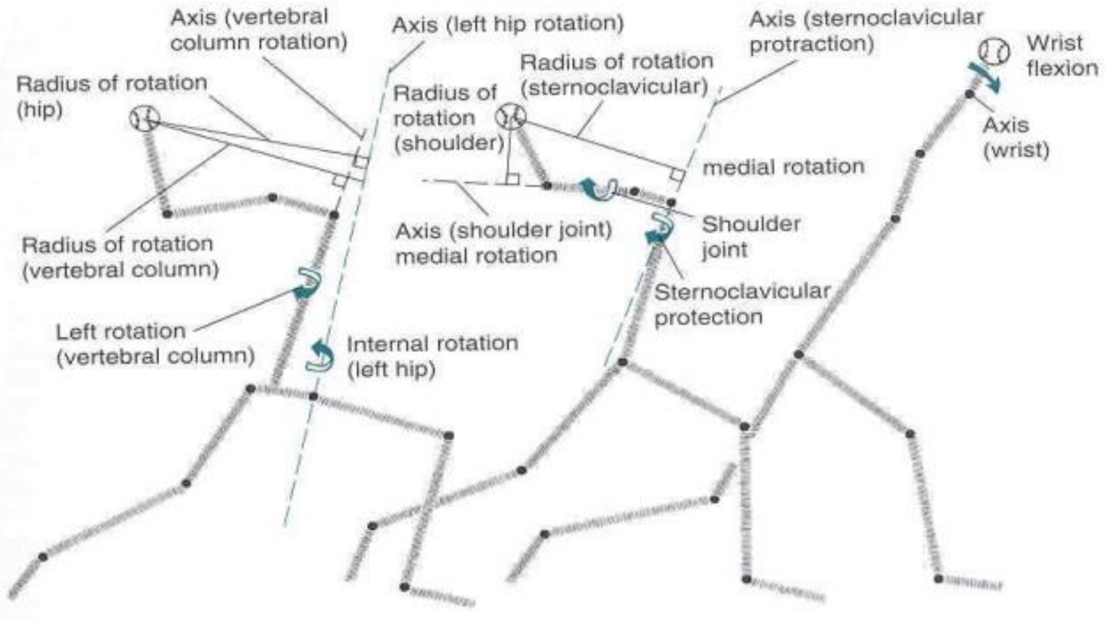
Limited definition : a segmental motion that all forces are continuously applied onto an external object (continuous application pattern of sequential movement)

- an individual pushes a desk across the room
- a traveler pulls his suitcase

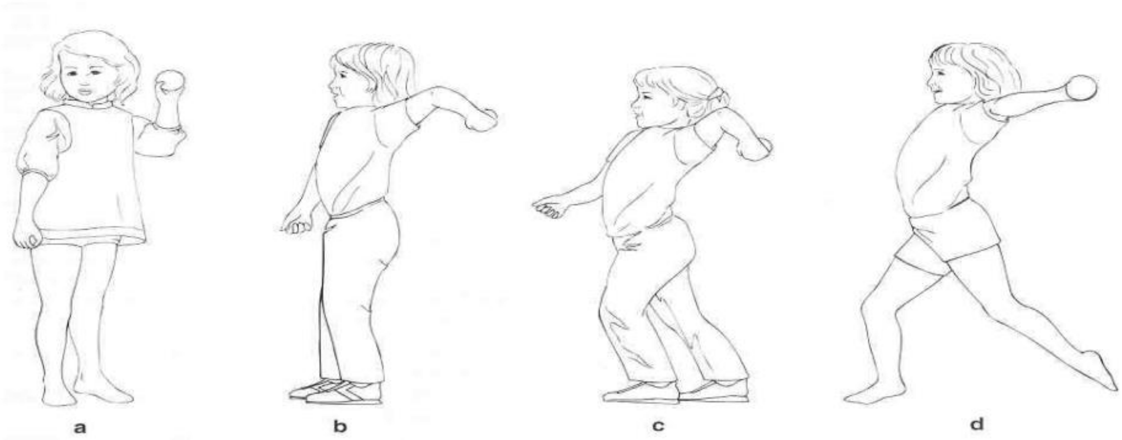
  Joint Action Patterns
  - simultaneous and opposite movement pattern in the upper extremity
  - flexion in elbow with extension in shoulder
  - extension in elbow with flexion in shoulder



A baseball pitcher, showing the step and the movements of the hip, vertebral column, shoulder girdle, shoulder joint, forearm, and wrist.



Axes of segmental rotations used in pitching a baseball.



The four developmental stages of throwing.

- Stage 1- ball thrown primarily with elbow extension – no rotation of thorax or arm
- Stage 2 - Thoracic rotation accompanies backward motion of the arm. The throw is initiated by the arm swing forward. Some arm rotation as well as forearm extension at various times
- Stage 3 - step is taken with same side foot to initiate throw
- Stage 4 – step is taken with contralateral foot, thoracic rotation, arm rotation, elbow extension

APPLICATION OF AERODYNAMICS IN SPORTS

The basic aerodynamic and hydrodynamic principles that govern most sports are identified. In turn, each concept is applied to a wide variety of individual sports, demonstrating how surface textures, form and shape of the equipment or athlete govern speed and motion and how performance can be enhanced.

SPORTS BALL AERODYNAMICS

Lateral deflection in flight, known as swing, swerve or curve, is well recognized in baseball, golf, tennis, cricket, volleyball and soccer. In most of these sports, the deflection is produced by spinning the ball about an axis perpendicular to the line of flight which generates the Magnus effect. It has long been known that the aerodynamics of sports balls is strongly dependent on the detailed development and behavior of the boundary layer on the ball's surface

BASEBALL AERODYNAMICS

For a pitch such as the curveball, the ball is released with topspin about the horizontal axis. This results in a Magnus force that makes the ball curve faster towards the ground than it would under the action of gravity alone.

GOLF BALL AERODYNAMICS

In golf ball aerodynamics, apart from the lift force, the drag and gravitational forces are also important, since the main objective is to "tailor" the flight path of the ball. The lift force is generated due to the Magnus effect and the role of the dimples is to lower the critical *Re*.

TENNIS BALL AERODYNAMICS

some recent experimental studies of tennis ball aerodynamics have revealed the very important role that the felt cover plays. The first observation is that the boundary layer over the top and bottom of the ball separates relatively early, thus suggesting a laminar boundary layer separation. However, since the flow field did not change with Re, it was presumed that transition had already occurred and that a turbulent boundary layer separation was obtained over the whole Re range tested, thus putting the ball in the transcritical flow regime.

CRICKET BALL AERODYNAMICS

Fast bowlers in cricket make the ball swing by a judicious use of the primary seam (six rows of prominent stitching). The ball is released with the seam at an angle to the initial line of flight

VOLLEYBALL AND SOCCER BALL AERODYNAMICS

In volleyball, two main types of serves are employed: a relatively fast spinning serve (generally with topspin), which results in a downward Magnus force adding to the gravitational force or the so-called "floater" which is served at a slower pace, but with the palm of the hand so that no spin is imparted to it.

HYDRODYNAMICS

Within the broad field of fluid dynamics, the definition of hydrodynamics pertains not only to the flow of liquids but to incompressible flow in general. In most water sports (swimming, rowing, sailing, water skiing, and powerboats), the equipment or the athlete is affected by the dual fluid medium of both water and air simultaneously. In a sport such as skin diving or the analysis of particular watercraft appendages, the body is considered fully submerged and only hydrodynamic (water) forces are of importance.

For the majority of water or marine sports the human body or the watercraft/equipment is either planing or surface-piercing and only partially submerged into the water or floating. A "water-line" is formed on the body at the free surface interface between water and air.

Effects may be time-dependant: a swimmer's hand and arm may be completely submerged or above water during different portions of a stroke. An oar may be out of or partially submerged in water during rowing. The forces acting on such objects are similar to those in aerodynamics: thrust, drag, lift, weight with the additional consideration of buoyancy. Fluid mechanisms associated with Reynolds number, boundary layers, flow separation, surface roughness, pressure and skin friction drag also apply to objects placed in water. In addition to the aerodynamic mechanisms, hydrodynamic forces are affected by: water waves and spray, ventilation (cavitation), fouling (marine growth on an object's surface), planing, the free surface interface and wind shear. Wave surface deformation occurs for a water surface-piercing body. Water peaks and hollows are formed along the body creating a component of drag called wave drag. This water piling can also form water jets, which shoot into the air creating spray drag. Planing refers to skimming or gliding over the water surface as opposed to plowing through water as a boat or other water displacement object. Planing is observed in sports such as windsurfing and water skiing.

HYDRODYNAMICS IN SWIMMING

Hydrodynamics plays a dominant role in the performance of both the human swimmer and the design of the swimming pool and lane dividers. In competition, athletes swim in prescribed lanes. As the swimmers dive into the pool and begin to swim, water waves form. These waves can expand into adjacent lanes, interact with other competitors and reflect off the gutters and sides of the pool. As the athlete turns at one end of the pool, waves are generated in opposing directions, interact, and can cause additional degradation in an athlete's individual performance. Subsequently, competitive pools are often considered "fast" or "slow"-- a fast pool is designed to minimize wave reflection and interaction which allows the athlete an opportunity for a faster race time. Considered the fastest pool in the world, the swimming pool designed for the 2000 Sydney Olympics used a gutterless system. The design resembles "a pool inside a pool" with water spilling over the sides of the pool, to eliminate interaction with gutters and minimize wave reflection. Floating lane ropes or lines separate the swimming lanes. Floating on the surface of the pool, modern lane rope designs are often rows of spinning wheels used to diffuse the wave and prevent water waves created by one athlete to expand and cross into the path of competitors in adjacent lanes. Four primary forces act on a swimmer: thrust (propulsive forces), weight, drag and buoyancy. The weight of the swimmer is offset by buoyancy and through the arm stroke and kick. By pressing down on the water, an equal and opposite reaction occurs which lifts the swimmer higher in the water. In addition to wave drag, the two other major components of drag are pressure drag and skin friction drag. Pressure drag results from water resistance over the swimmer's frontal area and the flow separation which occurs behind the swimmer. Therefore, a swimmer must streamline their body to reduce the amount of separation.

HYDRODYNAMICS IN SAILING

In competitive sailing, every fraction of a knot counts. Research in aerodynamics and hydrodynamics in sailing, related board (wake board) and power boat sports fills volumes of texts and conference proceedings. There is such great diversity in sizes, shapes and configurations of equipment that generalization is difficult. Researchers and designers often specialize in just one geometric element of analysis: sails, masts, hulls or appendages. Traditionally, research has been dominated with water channel and on-water design tests (the equipment is built and then sailed against other equipment). More recently, with the surge in available and affordable computational resources Computational Fluid Dynamics (CFD) has been incorporated into some marine sport equipment design. Aerodynamic and hydrodynamic simulation of marine sports equipment is a tremendous challenge. Realistic results require the modeling of multiple interacting components immersed in air, water or both fluids at the same time, as well as free surface (water wave) effects and wind shear effects. When a body moves through a free surface, the waves generated by the object play a primary role in the resulting flow and the forces on that object. The wave shapes near the body are determined by the pressure disturbance caused by the moving body. These waves propagated away from (and under) the object after it passes. Wind shear also affects the velocity profile along the height of a sail. At the water's surface, air motion is affected by friction. Surface wind (the wind from 0 -100 ft.) is different from the winds aloft. Similar to the formation of boundary layers, the wind velocity, influenced by factors such as hull shape, type of weather, and conditions at sea (wind turbulence, water roughness, air temperature) increases from the water surface upward.

Aerodynamics and hydrodynamics in sports is a wide-open research field. Significant opportunities exist to advance understanding, create innovation and enhance athletic performance of aerodynamics and hydrodynamics problems in sports.

In summary

There are 7 main common principles of biomechanics.

- Stability.
- Maximum Effort.
- Maximum Velocity.
- Impulse.
- Reaction.
- Torque.
- Angular Momentum.

The benefits of biomechanics

Basically, understanding biomechanics and applying it is the foundation for good technique in all sports. So, by studying how the human body naturally wants to move we can remove stress and pressure on the bones, joints, muscles and ligaments. This results in improved athletic performance, reduced injuries and heightened general wellbeing. Athletes of all ages and skill levels can benefit from biomechanical analysis whether it’s for pain reduction or to increase top level performance. Here are some more benefits of proper biomechanics:

- Increased movement speed (running, swimming, etc.)
- More power (jumping, hitting, lifting, etc.)
- Energy conservation through economy of movement.
- Helps eliminate muscle imbalances.
- Reduces wear and tear on joints and ligaments.
- Improved sport specific form and technique.

In a nutshell, with good biomechanics you can get faster and stronger while reducing injuries.

The Benefits of Studying Biomechanics

There has been a rising demand on expanding human understanding and knowledge of biomechanics. Many scientists specializing in different fields of science – biology, kinesiology, engineering, and physics, are interested in studying biomechanics. Biomechanics is becoming more interesting because people marvel at the ability and beauty of human and animal movement. In the world of sports, biomechanics has been applied greatly because of its ability to analyze sports movements in order to decrease the athlete's risk to certain injuries and improve their overall performance. But this does not apply in sports exclusively. Our understanding of biomechanics is needed for our daily activities. As humans, we are not immune to injuries and we are not at all times in our maximum performance. Biomechanics is essential to know how forces can create our movement and how this can affect our performance.

Improving Performance

The science of improving our performance involves neuromuscular skills, physiological capabilities, cognitive abilities and anatomical factors. Of course, it is hard to go through all of these. Well, biomechanics offer a simplified understanding onto how we can improve our performance by understanding the science of our movements. Most professionals prescribe the use of techniques and instructions of biomechanics in improving performance. Biomechanics is most useful in improving the performance of an athlete through improving the technique rather than relying on physiological capacity and physical built. Therefore, human movement is the most important contributor to performance. Teachers and coaches are encouraged to learn biomechanics. It will help them to correct actions of the athletes in executing the skills and acts perfectly. According to Peter McGinnis in his book Biomechanics of Sports and Exercise, coaches can use qualitative biomechanical analysis in everyday teaching to improve the technique of the athletes, resulting in better performance. It will also allow them to discover new techniques. Another way in which biomechanics can help in improving performance is integrating it in exercise and conditioning programs. Biomechanics was used by experts in developing exercise programs and training devices to improve performance. Strength and conditioning professionals apply the principle of biomechanics in training athletes. Biomechanics research also leads to the development of new techniques.

Preventing and Treating Injury

Biomechanics is also useful in promoting movement safety and injury prevention. Sports injury and medicine professionals studied the cases of injuries endured by athletes to know and identify what caused the injuries and how to prevent them. They have found out that the application of biomechanics can help in reducing the risk of the athletes from getting injuries. According to Knudson (2007), biomechanics provide knowledge on the mechanical properties of tissues, muscles, and bones that will help coaches and trainers in providing preventive measures and rehabilitative therapies. Moreover, occupational therapists and surgeons use biomechanics in devising equipment that will prevent the onset of injuries not just to athletes, but to everyone. Specially-designed running shoes have been developed through the principles of biomechanics. Further, the invention of helmets for motorcycle riders was based on biomechanics. Researchers studied auto accidents and applied biomechanical testing. Thus, they designed helmets to protect the important parts of the head during a collision or accident. On the other hand, severe accidents that result to body deformities or worst the amputation of certain parts can be addressed through biomechanics. To allow humans to continue its function in walking or moving their arms, they devised prosthetics. Prosthetics followed mechanical properties which match the movement of the human body. Because of prosthetics, disabled individuals are now able to function very well. Other applications of biomechanics in preventing and treating injury include forensic biomechanics and orthotics. Forensic biomechanics specialize in reconstructing the origin of injuries from basing it to accidental accounts and measurements. On the other hand, biomechanics aid in the development of assistive devices or orthotics. Orthotics are objects that are used to support or correct deformities in the body, including joints. Orthotics may come in braces and large assistive devices like canes or walkers. Moreover, biomechanics help therapists in performing rehabilitative exercises.

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