The Role of Biomechanics in golf

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Applied Biomechanics in sport

• « Biomechanics is the science that studies the forces acting on and in the biological structure as well as the effects produced by these forces » (Nigg, 1998)
History of Biomechanics in sport and golf

From the knowledge of the structures to the knowledge of the strength which are applied to it

- Leonardo da Vinci (1452-1515)
- Galileo Galilei (1564-1642)
- Giovanni Borelli (1608-1679)
- Newton (1642-1727)
History of Biomechanics in sport and golf

Movement analysis history / end of the 19th century

Movement photography, kinematics, MUYBRIDGE (1878), MAREY (18873 1st clothes for walk analysis, 1882 chronophotography)

Anthropometry, Military ergonomic, BRAUNE ET FISHER (1889, center of masse; 1895, analysis of human locomotion)
History of Biomechanics in sport and golf

Movement analysis history / 20th century

1955: Dempster tableboard, and concept of kinematic chains.

60’s: Ariel Gideon creates the First Digitizer in the World interface to the first Time Sharing in the World for Biomechanical Analysis.

70’s: A. Gideon makes 3d analysis coupled with EMG and with force Platforms.
History of Biomechanics in sport and golf

Bobby Jones 1934
World Scientific Congres of St Andrews 1990
Dr. Jobe Electromyography PGA Tour 1994
PGA Teaching Manual G Wiren 1995
Ralph Man 1998
Delacave-Rivet PGA European Tour 1998
Creation of Biomecaswing Lab at D Leadbetter 1998 Création Biomecaswing Lab chez D Leadbetter 1998
2004 : St Andrews / Titleist Perf Institute California / PGA Kinematic Lab Queensland Aus / Biomecaswing Asia Honk Kong / Sheffield University / ….
2011 : ETPI is following the PGA European Tour players. First time in the world an applied biomechanical service is used on the Pro Tour
Applied Biomechanics in sport

Bio
- Anatomy
- Biology
- Biochemistry
- Physiology
- Medicine
- Psychology

Mechanics:
- Physics
- Mathematics
Basic mathematical concept used in biomechanics:
- Vectors: describes forces, accelerations...
- Derivative function: position to velocity, velocity to acceleration. Integral function in the opposite way.
- Kinematics: part of mechanics which describes the displacement of a point or an object.
- Kinetic: introduces factor of length, time and mass to the description of movement (kinematics). Notion of energy!
- Forces: Newton's laws and creation of movement! i.e.: \( \Sigma F_i = m.a \) (in line movement equation)
- Internal and external forces: the body product and resist to many forces (skeleton joint, muscles production gravity, contact with environment...)
Derivative / integral function

- The derivative is a measure of how a function changes as its input changes (tangent of each point of the curve).
- The derivative of the position of a moving object with respect to time is the object's instantaneous velocity. Derivative of velocity function is the acceleration.
- The opposite of derivative is the integral (area under the curve).
Kinematics and kinetics

- **Kinematics**: is the branch of classical mechanics that describes the motion of points, bodies (objects) and systems of bodies (groups of objects) without consideration of the forces that cause it.

- **Kinetics**: is a term for the branch of classical mechanics that is concerned with the relationship between the motion of bodies and its causes, namely forces and torques.

- In mechanics, the Kinetics is deduced from Kinematics by the introduction of the concept of mass.
Forces (physics)

- In physics, a force is any influence that causes an object to undergo a certain change, either concerning its movement, direction, or geometrical construction. In other words, a force is that which can cause an object with mass to change its velocity (which includes to begin moving from a state of rest), i.e., to accelerate, or which can cause a flexible object to deform. Force can also be described by intuitive concepts such as a push or pull.
Forces: Newton laws

• Law I: Every body persists in its state of being at rest or of moving uniformly straight forward, except insofar as it is compelled to change its state by force impressed (Conservation of Linear Momentum)

• Law II: The change of motion is proportional to the force impressed; and is in the direction of the straight lines in which that force is impressed.

  => Force = mass x acceleration

• Law III: To every action there is always an equal and opposite reaction; or, the mutual actions of two bodies upon each other are always equal and act in opposite directions.
Body biomechanics

- Biomechanics body analysis will consider displacement / velocity of body part/members, joints angles, force applied to the skeleton and the body, force produced by the body... in order to prevent damages and optimize the motion most efficiently!
It is all about Rotation and control

**Rotation**

- Free range of motion and control of the rotation around the human body joints
- Harmony of the kinematic muscular chains playing around the human body’s joint
- Synchronization of segment which resists to rotation, or which starts/stops rotation in a certain direction
- Combine rotation to create a global translation
• The center of gravity of a body is the barycenter of all the particles making up this body, every particle is balanced by its own mass.
Applied Biomechanics in sport
Applied Biomechanics for the golf swing

Golf kinematics analysis with 3D kinematic system
Applied Biomechanics for the golf swing

• From the 1930s to today

"President Ford actually has a smoother and faster over-all swing than Nicklaus but his timing is not as good. He can't time the club as well."

swing is a shade that would prevail for all golfers. To some extent the scientific community corrected itself, thanks to the work of Dr. E. A. G. Hegg of the University of Pennsylvania, whose experiments indicated that a player's swing is not affected by the brain, but is governed by the muscles of the body, which are innately wired to perform certain tasks. These "tasks" are what Hegg called "the body's natural movement patterns." The movement patterns are thought to be determined by the brain, which in turn controls the muscles. The muscles control the movement of the body, which in turn controls the swing. The swing is a complex process that involves the musculoskeletal system, which is controlled by the brain.
Mechanics of the club

**Speed Pocket**

- Gives the face more flexibility creating more speed.
Mechanics of the ball

**4308** λpp** backspin

**252** sidespin

**153** rifle spin

Total spin: **4318**
Mechanics of the golfer

6 Keys Areas of Performance

- **Max. ROM**
- **Max. Separation**
- **Energy Transfer**
- **Synchronisation / Coordination**
- **COG Management**
- **Explosiveness**
Kinetic Energy Transfer (CORE Power)
SYNCHRONISATION / Co-ordination
RANGE of MOTION (Flexibility)
MAX SEPARATION
It is ALL a QUESTION of controlling the Rotation and Maintaining the COG stable
Evaluation of muscular coordination

- Flexion
- Closing Chain (anterior)
- Extension
- Opening Chain (posterior)
It is ALL a QUESTION of closing the kinematic muscular chain’s engagement
Conclusion: Factors to Enhance and Maintain the KEY AREAS of PERFORMANCE

**Explosiveness & Accuracy**
- Core stability
- Separation (dissociation)
- Foot grounding (weight transfer)
- Kinetic energy

**Biomechanical Factors**
- Alignment
- Balance
- Coordination

*Image: A good alignment leads to an efficient movement.*
ETPI Concept

ETPIme™ – The circle of knowledge, understanding and improving

OUR SIX STEPS TO SUCCESS ‘ETPIme’

1. EVALUATE the golf swing and ball flight
2. TAKE the data
3. PROBE the data
4. IDENTIFY the solution
5. MAINTAIN golf swing
6. EVOLVE the golf swing
Evaluate the golf swing and ball flight

- Discussion of the technical characteristics of the swing in collaboration with the coach
- The swing evaluation process uses cutting-edge motion analysis technology.
- Evaluation of the swing according to the criteria of the applied biomechanics. This will be done with High speed camera (Mikrotron), motion analysis software such as the analysis in 3D with the APAS software from ARIEL KINEMATICS, and the aG Balance Pro Force plates and aG Studio from aboutGolf to track the club and the ball.
Take the data

- Assess biomechanical and physiological capacities of every individual
- Fill in a detailed physio/medical questionnaire
- Test flexibility, coordination and muscular strength
- Collecting biomechanical data using systems such as SpineForce, PostureWin, Myotest...
The objective when probing the data collected is to establish a personalized balance sheet placing the golfer’s technical problems in relation with his/her biomechanical problems and the functioning of his/her body. Probing involves:

- Analysis of the elements exerting an influence on the specific swing motion
- Examining the correlation between the biomechanical dysfunctions and the technical weaknesses.
Tailored solutions are developed to address the individual problems. The solutions are fitted to the individual’s body specifics and physiological capabilities.

The program is based on 4 axes:

- Axis 1: postural Optimisation
- Axis 2: myofascial stretching
- Axis 3: muscular strengthening
- Axis 4: muscular coordination

A tailored program is designed for every golfer.
Maintain & Evolve the golf swing

- Comparison of swing before and after the solutions have been implemented, validation of specific keys.
- Application and validation of the personalized ETPIme program in situ.
- Measurable increase of overall performance.
Thanks for your attention!