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Biomechanical and technological knowledge: Integral part of sports science

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Abstract

Sports biomechanics is the sport science field that applies the laws of mechanics and physics to human performance, in order to gain a greater understanding of performance in athletic events through modeling, simulation and measurement. It is also necessary to have a good understanding of the application of physics to sport, as physical principles such as motion, resistance, momentum and friction play a part in most sporting events. Biomechanics is a diverse interdisciplinary field, with branches in Zoology, Botany, Physical Anthropology, Orthopedics, Bioengineering and Human Performance. The general role of biomechanics is to understand the mechanical cause effect relationships that determine the motions of living organisms. In relation to sport, biomechanics contributes to the description, explanation, and prediction of the mechanical aspects of human exercise, sport and play. The laws of mechanics are applied to human movement in order to gain a greater understanding of athletic performance and to reduce sport injuries. Biomechanics in sports can be stated as the muscular, joint and skeletal actions of the body during the execution of a given task, skill or techniques. Proper understanding of biomechanics relating to sports kill has the greatest implications on sport's performance, rehabilitation and injury prevention, along with sport mastery. The ability to teach the basic skills, techniques of a sports/games or physical activities mainly depends on their knowledge of the effects that they are trying to produce and of the forces that cause these effects. The importance knowledge of biomechanics to a coach depends to a certain extent on the sport involved and techniques play a significant role in total performance e.g. Gymnastics, Football, Basketball, Swimming, Tennis and Cricket etc. The coach on the other hand, works at increasingly more advanced levels and hence is concerned not only with broad fundamentals but also with precise details. As the level of performance increases, so the coach needs at ho rough knowledge of biomechanics where techniques play a very important role. Therefore, the knowledge of sports biomechanics is very essential for coaches to raise the level of performance of their athletes/trainees. The biomechanical analyses enable the athletes and coaches to acquire a clear picture regarding the performance. This will provide virtual feedback so that error identification enhances and thus reduce the wastage of energy which allows the maximum conversion of all the desired performance and activity.

Keywords: Biomechanics, Coaches, Mechanics, Movement, Performance, Physics

Introduction

Technology in physical education has made greater impact in education of games, sports and exercises scientifically thought e-teaching, e-coaching, e-learning, etc. bio-mechanics emphasizes on application of mechanical principles to living organisms to gain greater advantage for human sports performance. The use of technology in the sports industry comes handy in terms of coming up new sports equipment that can help improve the performance of athletes and the whole sporting world in general. Technology can make athletes become stronger, taller and perform better.

The optimization of the efficiency of movement and the effects of training require a deep knowledge of the human body and its motions. Performance improvements and injury prevention are made possible by the extensive biomechanical research conducted all over the world. In sports research it is not always possible to perform countless repetitions of a certain skill to observe and extrapolate possibilities, and a musculoskeletal model is sometimes a useful alternative. New developments that have been theorized may eventually be reflected in performance improvement. Musculoskeletal modeling and simulating movement can explore the boundaries of human motion and assist in quantifying best practice in training, injury

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prevention and improving the quality of sport. The noted Dr. Michael Yessis says that "Best athlete is the one that executes his or her skill the best". Biomechanics is the science concerned with the internal and external forces acting on a human body and the effects produced by these forces.

Biomechanics is the study of the structure and function of biological systems by means of the methods of mechanics, which is the branch of physics involving analysis of the actions of forces. The word "biomechanics"(1899) were invented by Nikolai Bernstein from the Ancient Greek Bios means "Life" and mechnike means "Mechanics", to refer to the study of the mechanical principles of living organisms, particularly their movement and structure.

Sports biomechanics is the science of movement of a living body, including how muscles, bones, tendons and ligaments work together to produce movement. It is a quantitative based study and analysis of professional athletes and sports activities in general. It can be simply described as the physics of sports. It is important to remember that human movement occurs in an environment that is constantly changing, even as the person changes biologically. The body is always adjusting to an ever-present force in its environment the force of gravity. The task we chose to perform as well as how we perceive the task influences the movement. The movement patterns will be different depending on which goal we chose. It is interaction of the person the task and the environment that determines the movement.

The branch of physics concerned with the effect that forces have on bodies and motion produced by those forces. The laws and principles used to explain the motion of planets or the strength of buildings and bridges apply equally to humans. All motions including the motion of the human body and its parts, is the results of the application of the forces and is subject to the laws and principles that govern force and motion. Biomechanics analyses of fundamental human movements begins with a discussion of the principles of biomechanics and then continues into more advanced study involving the mechanical and mathematical bases for a range of fundamental human activities and there variations, including balance, slipping, falling, landing, walking, running, throwing, lifting, striking, catching, climbing, swinging, jumping mechanics, object manipulation, variations, enhancement and safety.

Sports bio-mechanics

- Bio-mechanics is mainly concerned with the forces (different in nature) that act on a human body and the effects that these forces produce.
- Physical education teachers, sports and games teachers' coaches of sports and games and even athletes and players are also much concerned with forces and their effects.
- The ability to teach the basic skills, techniques of a sport/game or physical activity mainly depends on their knowledge of the effects that they are trying to produce and of the forces that cause these effects.
- Therefore, physical educators, coaches and athletes should look to biomechanics for the scientific analysis of sport and game techniques performed by the athletes.
- The Mechanical bases of biological; muscular activity and the study of the principles and relations involved.
- The application of mechanical laws to living structures specifically to the locomotion system of the human body.
- The study of the structure and function of biological systems by means of the methods of mechanics.

- Biomechanics is the science concerned with the internal and external forces acting on a human body and the effects produced by these forces.

Application of Sports Technology

Technology has an important role in sports, whether applied to an athlete's health, the athlete's technique or equipment characteristics. As sports have grown more competitive the need for better equipment has arisen. Camera stumps, aerodynamic javelin, power cricket bats, hockey skates, baseball sluggers, tennis racquets, soccer balls, golf clubs.....etc. The equipment has all seen considerable changes when new technologies have been applied. The systematic training principles are law of overload, law of reversibility, law of adaptability, law of specificity, principle of individualism, principle of variety and principle of active involvement.

The sports science has now acquired its place and has gained status within the vast domain of science and thus gained strategic significance. Science is a significant force in the field of sports that searches for solution to performance problems and explores factors that influence these problems. Advanced technology created new opportunity for research into sports. It is now possible to analyze aspects of sports that were previously out of the reach of comprehension. Being able to use motion capture to capture an athlete's movement or advanced computer simulations to model physical scenarios has greatly increased an athlete's ability to understand what they are doing and how they can improve themselves.

Sports technology has found its greatest proponents among professional athletes. In the twentieth century, the entire face of sports changed drastically with the advent of new technologies. Today advertisements for new types of running shoes, golf clubs, tennis rackets and hundreds of other sports accessories bombard us. With new materials and computer engineering, improvements are being made on sporting equipment faster than marketers can publicize them. This advance in technology has broadened the spectrum of athletes. Improvements in safety standards, cost, have allowed more people to take advantage of formerly exclusive sporting events. Advances in sports equipment have undoubtedly played a role in the achievement in their respective fields.

Video Analysis in Sports: Video has many applications in sports and science. Coaches and athletes are using the medium more and more to measure and correct technique, and to analyze team and individual performances. Video analysis software can also be used for gait analysis and biomechanics research, and in injury rehabilitation.

Team Performance Analysis: With the correct software, video of match play can become much more useful than simply re-watching the game. First it requires a technician to mark the video (in real time or after the game) with your chosen key points such as goals, errors, and specific plays, and also mark the involvement of each player. The coach or player then has ability to filter and see their chosen aspect of the game, such as all goals by a specific player, or errors by the opposing team. Game highlights can be quickly generated, and you have instant access to many aspects of performance.

Technique Analysis: Video analysis of technique is very useful for identifying and correcting problems with an athlete's technique. Things that can be measured and

identified using video analysis include the following:

- Angle of release of thrown implements
- Ball release velocity and the arc of travel of the thrown implement.
- The head and body position during technique performance.
- The joint and segment angles and velocities.

Angle of Release: For an object released at ground level, for any given release velocity, the maximum distance is achieved (Javelin throw) using an angle of approximately 45 degrees. However, as most implements in sport are released at a height above the ground, say from about shoulder height, the optimum angle at release is somewhat less than 45 degrees. For example, for the shot put, the optimum release angle is 40-42 degrees, and for the hammer throw it is 43-44 degrees. The actual ideal release angle can depend on the technique and physical attributes of the athlete. If the athlete can get a higher velocity at a lower angle, then there has to be a trade-off between the optimum release angle and maximum release velocity. This is often something that is worked out with trial and error overtime.

Fast Bowling: Biomechanics research into cricket has focused on improving and understanding of the relationships between fast bowling technique and improvements in performance and the likelihood of injury. In terms of injury potential (lumbar stress injuries) the research has moved away from the traditional back foot contact bowling action classification system and focused on the front foot contact phase of the delivery stride where the spinal postures are extreme and loading on the lower back is greatest. It is proposed that concurrent lower trunk extension, rotation, and extreme side-flexion during the early part of the front foot contact phase of the bowling action, at a time when ground reaction forces are also high, is the most important mechanical factor in lumbar stress injuries. These results contradict some of the current beliefs in cricket but tie in very closely with javelin research and suggest that the fastest bowlers maximize their horizontal breaking impulse during front foot contact as opposed to peak ground reaction forces and loading rates.

High jump: The use of computer simulation models of high jumping to address questions such as how the approach speed, leg plant angle and knee angle at touchdown affect high jumping performance and why elite jumpers use a curved approach.

Triple Jumping: The optimum technique in triple jumping using computer simulation. A double-arm technique is shown to be the most beneficial and potential mechanisms for this benefit are meticulous. The change in arm technique and actual performance and an optimized simulation of the ground contact in the step phase of a triple jump.

Diving takeoffs: Research into springboard diving using computer simulation models has addressed questions of techniques for generating somersault rotation during takeoff and twist rotation during flight.

Force platforms or force plates are measuring instruments that measure the ground reaction forces generated by a body standing on or moving across them, to quantify balance, gait and other parameters of biomechanics. Most common areas of application are medicine and sports.

Electromyography (EMG) is an electro-diagnostic medicine

technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG is performed using an instrument called an electromyography, to produce a record called an electromyogram. An electromyograph detects the electrical potential generated by muscle-cells when these cells are electrically or neurologically activated. The signals can be analyzed to detect medical abnormalities, activation level or to analyze the biomechanics of human or animal movement.

Latest Gadgets and the Performance

The sports technologists have applied their ingenuity, creativity and expertise to develop better and safe equipment in the quest for sporting excellence, from the sports shoe to the swimsuit and the tennis racket to the football. The outcome has been enhanced performance better, safer and more effective sports equipment, precision measurement of performance, a multiplicity of ways to experience sporting events anywhere and at any time. The innovation of wide range highly sophisticated man-made materials including alloys and polymers. Stronger and lighter sports equipment made with these high-tech materials has enabled sportsmen and women across the globe to reach new heights of achievement while minimizing the risk of injury, and has helped sports enthusiasts everywhere to enhance their performance. The training equipment like aquatic wheelchairs, starting block assemblies, stopwatches, golf clubs and gym equipment, sports drinks, muscle-building and nutritional supplements. The technological advances in sporting equipment have added significantly to athletic presentation.

- David Duval became the 2001 US Open golf champion because he used a titanium golf club
- Marion Jones wore ultra-light running shoes and tireless training that captured the 2000 Olympic gold medals in the Women's 100M and 200M races.
- At the Atlanta Olympics, Michael Johnson became the first male athlete to win both the 200 and 400 meter sprint, He also set the new world record in the 200meter sprint wearing specially designed ultra-light Nikerunning shoes weighing just 3.4 oz (96.39 g).
- Many sprinters also wear full-body suits to reduce wind resistance, which could make the critical hundredth of a second difference in a race.
- The tennis player Venus William used graphite tennis rackets, and won the Wimbledon in 2001.
- Athletes were performing without the benefit of graphite tennis rackets, fiberglass poles, ultra-light running shoes and titanium golf clubs.
- The modern poles are made out of fiberglass and are much lighter than their bamboo or metal counterparts. The lighter pole allows athletes to run faster and gains the momentum they need to vault higher. The new poles also have more spring action. The fiberglass pole absorbs more of the vaulter's energy when it bends and as it straightens.
- The advent of aluminum, fiberglass and graphite poles, the pole vault record shot up 2 ft (0.61 m) in three years and now stands at over 20 ft (6.09 m). Prior to that technological innovation, the pole vault record increased only about 2 in (5 cm) to 16 ft (4.88 m) between 1942 and 1960.
- The first ever women's 2000 Olympic gold medalist Stacy Dragila (America) in pole vault, it's impossible to ignore how improvements in sports equipment contributed to their success.

- The Multi-Sport GPS watches offers real time information such as time, distance, heart rate, place, speed and calories burnt to runners, cyclists and swimmers. The watches have got a Quick GPS Fix, scratch resistant display, Bluetooth Smart technology and an indoor tracker.

Sports have an intimate quality that makes the use of technology seem too intrusive. The tools athletes use and the advances they take advantage of medicine, training, nutrition, and psychology have not presented any serious threats to sports. As long as the integrity of the game and the safety of athletes are not seriously violated by technological advances, athletes will still be the heroes of the games. The advanced technology in sports has significantly narrowed the gap between world record holders and the way the athletic achievement is perceived. The latest trend in the modern technology in sports is to create an atmosphere similar to the actual sports and games situation so that before the actual competition the competitors can identify the ways and means to defeat the opponents. The most advantage of this type of analyses is that the area of performance pre-requisites, deficiencies and advantages can be observed well in advance and the popular training can be adopted for the development of better performance factors.

Conclusion

- Physical education has been defined as a process through which favorable adaptations and learning organic, neuromuscular, intellectual, social, cultural, emotional and aesthetic result from and proceeds through fairly vigorous activities.
- To determine the internal and external forces acting on a human body.
- To know and understand how human body parts are moving during the performance of motor skills.
- To use and understand the different types of force for learning a wide range of techniques in sport and exercise.
- To apply the trial and error method of learning sport, physical activity, exercise and improve performance with economical expenditure of energy.
- To create the best base for acquiring skills, techniques and performing the same several times through which a way now techniques are developed for personal advantages.
- To attempt for improving techniques/technical performance as an ongoing process in most of the sport.
- To make use of an appropriate technique to the situations for benefits and advantages over opponents or situation so that new records are made by upsetting formal/old techniques to marginal/great extent.
- To create overall champion having used bio-mechanical principles carefully in a particular segment of skills and technique.
- To make teachers and coaches well equipped with knowledge of motor learning and sound judgment on methods of instructions, length, frequency, nature of practice etc.
- The knowledge of Bio-mechanics equips the coaches and teachers to choose appropriate techniques and to detect the root causes of faults that may arise in their use.
- The importance of knowledge on bio-mechanics to a coach depends to a certain extent on the sport involved and techniques play a significant role in total performance.

- Physical education teacher, generally works with beginners or near beginners and so is concerned with the broad fundamentals of sports techniques and the broad mechanical principles underlying with them.
- The coach on the other hand, works at increasingly more advanced levels and hence is concerned not only with broad fundamentals but also with precise details.
- As the level of performance increases, so the coach needs a thorough knowledge of biomechanics where techniques play a very important role.
- Therefore, the knowledge of Bio-mechanics is very essential for coaches to raise the level of performance of their athletes/trainees. On the other hand, there is not clear cut compact evidence that the knowledge of biomechanics to the athlete is essential.
- In many cases, as athletes advance and aspire for higher achievement in competition, bio-mechanical knowledge application by the coach remains authentic.
- Sports technology is not just limited to improvements in equipment.
- The modern-day athlete can now depend on computerized training systems to analyze their swing, stride and follow-through.
- As the equipment and training regimes of athletes become more sophisticated, technological innovation will play a larger role in dictating winners and losers. In the future, records will be broken in vanishingly small increments, not because there are no more great athletes, but because technology is helping to optimize the performance of all.

The sports biomechanics how and why a basic understanding of kinematics and kinetic helps to produce an improved performance. It helps the trainers/coaches and physical education teachers to be able to look at the players/athlete's performance. When the corrections are made they have a more efficient technique and provide a better performance. The advanced technology will make more of a difference in the future than it has in the past. People appreciate sports for different reasons because sports provide entertainment, celebrity, instruction and development, commerce, aesthetics etc. The community often comes to a better understanding of the possibilities for improving their health by observing sports and hearing details of sports treatments and training. Sports provide a market that supports the development of new materials and the study of the physics of athletic equipment. It is certain that athletes will continue to utilize advances in sports technology to enhance and better their performance.

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