IMPACT OF ENGINEERING AND TECHNOLOGY IN SPORTS SCIENCES: AN OVERVIEW

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ABSTRACT

Engineering is a creative discipline, and its science is in sync with living science, thus it can be found in almost every element of daily life. It is no surprise that engineering finds its place in sports sciences and so-called sports engineering. Sports engineering can be considered a new engineering discipline, bridging the gap between two distinct fields: sports science and engineering. There is no doubt that engineering and technology have played a vital role in sport, particularly in the design of sports equipment and high-performance athletics, as well as making sports more enjoyable and safe. From tennis rackets to swimsuits, engineers design with the goal of making equipment that is lightweight, fast and strong. High-tech, well-designed equipment allows athletes to perform at their best while being safe. Energy transfer is the most significant scientific topic for most designed sports equipment. This article provides an insight into the impact of engineering and technology in sports sciences in many ways that turn it into a more exciting and competitive world event than in the past.

Keywords: Sports Engineering, Sports Technology, Sports Science, Research impact

INTRODUCTION

Sports engineering is a relatively young engineering subject that has gained traction in recent years. The existence of its essence, on the other hand, stretches back centuries. Great scientists have utilised sports to depict scientific phenomena and vice versa. It is not unusual for the general public to be unable to distinguish between sports engineering and sports science. Sports engineering is the technical use of mathematics and physics to address athletic problems through the design, development, and research of external technologies that athletes employ to improve their performance. Sports science, on the other hand, is the study of an athlete's movements, physiology, biomechanics, and psychology. The greatest sports engineering research applies sound engineering concepts to equipment and employs sports science skills to evaluate the athlete's and equipment's enhanced performance. Sports engineering is the art and science of designing, making, and maintaining different sports goods, sports infrastructure, and other supportive products. Sports engineering, on the other hand, investigates the scientific elements of sports performance by examining the performance of players, sports products, and other materials that influence sports performance with the goal of improving the whole sporting experience. In its wings, sports engineering encompasses a wide range of sports-related topics. The sports engineer must be skilled in a variety of technical areas, including mechanical design, aerodynamics, material science, and computer modeling. Sports engineers are those who study the design and construction of new equipment depending on the needs of athletes. They observe the behavior of equipment, athletes and their interaction in a controlled environment. In addition, they analyze and simulate the forces acting on athletes and their equipment (Finite Element Analysis), as well as the airflow surrounding the equipment (Computational Fluid Dynamics). Some of them work with regulatory organizations to examine the impact of rule changes or to better understand damage risks. Sheffield University is credited with helping to establish the area in the late 1990s by hosting the first and second International Conferences on the Engineering of Sport, which were held in Sheffield, UK in 1996 and 1998, respectively. On the second meeting, the International Sports Engineering Association (ISEA) was founded. In 2000, the third conference was held in Sydney, and in 2002, the fourth was held in Japan. The conference continues to attract and pique the interest of sports engineers all around the world. The 6th conference, held in Germany in 2006, had a total of 181 oral speakers, which was the greatest number ever recorded. The 10th conference of the series will be held on July 2014 at the Sheffield Hallam University (UK) [2]. The 14th conference on the Engineering of Sport will be hosted by the Ray Ewry Sports Engineering Center at Purdue University on behalf of the International Sports Engineering Association (ISEA) and will take place 6 to 9 June 2022 [3]. The ISEA's mission includes coordinating sports engineering research and serving as a global debate platform. The ISEA's official journal, Sports Engineering, has been published since 1998 and is the longest-running magazine in the subject of sports engineering and technology.

IMPACT OF ENGINEERING AND TECHNOLOGY IN SPORTS SCIENCES

Humans have improved our lives via the use of tools and technology. Without a question, engineering and technology have played an essential part in sports, not only in boosting an athlete's performance but also in making sports more interesting while remaining safe. In a variety of sports, a large amount of technology is used. As a result, the technology applied in the field of sports engineering is divided into four independent technical disciplines: materials engineering, computer modelling, instrumentation, and design and ergonomics, to mention a few.

MATERIALS ENGINEERING

The creation of novel textile materials for sportswear, the invention of new materials for sports equipment, and the development of new materials for sports playing surfaces are all examples of materials engineering in sports. Metals, ceramics, and plastics/polymers are the three primary forms of materials, followed by composite materials, which are a combination of two or more types of materials. Engineers may be working on developing new materials or upgrading current ones to make them stronger, lighter, or more flexible, depending on the activity. Understanding the qualities of various materials helps sports engineers to design a piece of equipment that will execute its function effectively (while still adhering to standards) but also taking into account competition circumstances and how the athlete will use it. Hardness tests, stress-strain tests, impact tests, failure/fatigue tests, and other materials testing techniques should be familiar to engineers working in this field. The hardness of the court, for example, may have an impact on how well players perform in

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tennis. All of these are inextricably linked to other fields such as mechanics, design, and production. Advances in materials and design, for example, have practically rendered the formerly renowned hour record a farce, forcing the UCI to break it into three categories. The best human effort, set on any bike [4], the UCI hour record, set on a 1980s style steel framed bike, the UCI unified record, set on a contemporary individual pursuit bike, and the UCI unified record, set on a modern individual pursuit bike. Furthermore, early developments in swimsuit design aimed to minimize drag by making the swimsuit as compact as feasible. Then, in the 1950s, nylon was developed to replace the traditional woolen fabric, which tended to absorb water throughout the race. Suits were cheaper, better fitting, and more pleasant to wear after the advent of Lycra in the 1980s. Speedo created a new swimsuit in the early 2000s that was inspired by shark skin texture. At the Sydney and Athens Olympics, swimmers wore it. In 2008, Speedo released the LZR, a groundbreaking swimsuit developed in conjunction with NASA. It is made out of ultrasonically welded together polyurethane panels. The seamless design ensured that the water flow would not be disrupted. The polyurethane panels also assist to trap air, which increases the swimmer's buoyancy.The tight structure of the body suit helped reduced the effects of drag by moulding the swimmer into a more streamlined shape. Over the course of two years (2008–2009), the LZR suit and other polyurethane full body suits were worn, and more than 130 world records were broken.

Aside from textiles, the development of composite materials has had a considerable influence on sports like pole vaulting. The pole vault was won with a height of 3.30 metres in the 1900 Olympics. Sergey Bubka established the world record for pole vaulting in 1994, clearing 6.14 meters, an 86 percent increase [5]. Material advancement has resulted in a significant rise in pole vault height. Solid wood vaulting poles were used in the beginning. It was hefty, which limited the athletes' run-up speed and, as a result, slowed their launch velocity. The pole must be capable of storing huge quantities of energy without breaking while maintaining a low bulk [6].The invention of artificial playing surfaces, such as field hockey, is another example of modern material engineering in sports. Originally, field hockey was played on grass pitches. In the 1970s, field hockey fields began to use artificial grass made of polyamide/nylon material. The synthetic turf fields provided a flatter playing surface than natural grass, which was great for field hockey. This, in turn, improved ball control by preventing the ball from flying off in all directions. Sand was put between the fibers to provide the players extra stiffness and stability. Artificial grass was initially utilized in field hockey events in the 1976 Olympics because of these fundamental characteristics.

COMPUTATIONAL MODELING

Computational modeling is widely utilized to depict complex systems across many engineering fields. Computer fluid dynamics (CFD) and finite element analysis are two noteworthy computational modeling methodologies (FEA). FEA is a numerical methodology for finding approximate solutions to boundary value issues for differential equations, whereas CFD is a field of fluid mechanics that employs numerical methods and algorithms to solve and analyse problems involving fluid flows. Typically, we'll need a 3D model of whatever needs to be tested, such as a new bike helmet design, then load that 3D model into simulation software, configure the desired parameters (such as position, wind speed, and so on), and run the simulation. Before we develop the product and test it in real life, we use simulations to have a solid sense of what works and what needs to be improved. We can also undertake mechanical and temperature simulations in addition to air/fluid flow simulations (or Finite Element Analysis). In those circumstances, a basic grasp of material qualities, mechanics and physics (which we shall discuss next), as well as the test conditions, is required. Cycling is a good example of a sport that has been changed significantly by CFD. CFD study was utilized to evaluate the bike's, rider's, and clothing's aerodynamics. It's used to simulate how air moves over an item and deliver helpful information like drag coefficients and pressure maps. Furthermore, FEA is a cutting-edge engineering technology that has been frequently employed to decipher the physics of sports equipment. To simulate events like a tennis hit, testing sports equipment often requires dynamic finite element (FE) models. For example, FE models of a tennis racket and ball can analyse the five-millisecond impact when the ball makes contact with the racket. The FE model can predict all aspects of the impact, including the vibrations in the racket, the compression of the ball, the deformation of the string bed, and the rebound dynamics of the ball, thanks to the use of a non-contact 3D laser scanner and material characteristics obtained through materials testing [7].

INSTRUMENTATION

Instrumentation including sensors and electrical components, such as video technology that aids officials' choices, also plays a vital part in pushing sports to a whole new level. Franz Konstantin Recently, Fuss et al. [8] investigated the effect of instrumentation on sports balls during flight, exemplified by a smart AFL ball. Where he provided a method for assessing the (moment of inertias) MOIs of a smart ball by means of spin rate data, collected from a gyroscopic sensor. The Hawk-Eye technology, which is utilized in tennis, is a good example. Hawk-Eye employs a network of on-court cameras to follow the ball's flight and estimate where it will fall using modelling techniques. Hawk-Eye was introduced in 2005 and the system now offers players three challenges to umpire decisions. Laser-timing technology developed for cycling is another modern example of sports instrumentation. The previous break-beam technology couldn't tell whether there were many bicycles racing around the track at the same time. As a result, BAE Systems has created a new laser timing technology adapted from a combat identification system that enables for individual performance tracking of up to 30 motorcyclists racing against each other in real time second by second. Each bike is equipped with a vintage reflective tag that has a unique code that is read by the laser. Individual timings may be captured with millisecond precision thanks to the technology. This is a significant advancement in cycling training that has contributed to the British Cycling Team's recent success in international competition.

DESIGN AND ERGONOMICS

Running, riding, and skiing, for example, have evolved and improved through time, as have athletes' expectations for ergonomic apparel. The British cycling team won seven of the 10 gold medals available at the 2008 Beijing Olympics. The outfit that the British cyclists were wearing was one of the variables that contributed to their outstanding achievement.

The 'hot pants' are a standout aspect of the costume. However, owing to the practicalities of racing, they must halt around 10 minutes before to the start of the race to prepare and be in the proper location. Their muscles cool down as a result of this. The suit, which is composed of a Lycra-like material, comes with strips driven by batteries that heat the muscles to 35 degrees Celsius, resulting in an increase in muscular mass, thus deliver an increase in power when the race begins. The 'bolero,' a one-piece aerodynamic leading edge, similar to the front of an aeroplane's wing, is reported to be particularly aerodynamic in the latest cycling suit released by adidas AG for the British cycling team. This design is believed to provide the cyclist with optimal efficiency and speed. The Clima Cool technology, which is based on a body-mapping approach for enhanced ventilation on the rear of the jersey, is another remarkable feature. The sweat zones of the body are mapped using a body-mapping approach. The suit is meant to distribute airflow through the garments and into the sweating zones where the athletes sweat the most, ensuring that the body does not overheat. The latest sports textile materials are much more functional for fulfilling specific needs in different sports activities. For example, in the 2008 Olympics, some cycling teams introduced athletic gear with attached battery strips to heat up the muscles before the race for enhanced performance.

CONCLUSION

In conclusion, sports engineering and technology play a critical part in sport. New technology can help a sport stay current and alive. Sports engineering has made things conceivable that we may have thought impossible five years ago. Consider the uproar surrounding Oscar Pistorius, the world's fastest man without legs. Individuals with severe impairments may now compete at the highest levels thanks to new technology. This field has had a huge influence on sports, and it continues to do so now. Sports engineering has truly become a game-changer, revolutionizing sports as man has never seen them before, thanks to quick technological advancements and cutting-edge research. Soccer pads and helmets, for example, must absorb high-energy collisions. The greatest golf clubs deliver as much energy as possible to the golf ball. To build effective athletic equipment, engineers must be able to grasp and use the principles of kinetic and potential energy.

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