

Technosport and Nanotechnosport

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Abstract: Technological advancement is a natural process, and with its introduction into a sport, athletes simply become “better”. Technologies in sports are man-made means developed to reach human interests or goals in or relating to a particular sport. Technology in sports is a technical means by which athletes attempt to improve their training and competitive surroundings in order to enhance their overall athletic performance. It is the knowledge and application of using specialized equipment and the latest modern technologies to perform tasks more efficiently. In this, paper discussed efficient technologies i.e. technosports and nanotechnosports that will help in enhancing the performance and quality of sports and also a scope of global sports industry.

Key Words: Technology, Nanotechnology and Sports.

1. INTRODUCTION :

Technology in sports today is a fast-growing field. The desire to move faster, recover quicker and last longer, have led to the increased integration of technology into sports. The prevalent fields of today's research and high tech products are textiles, material science and electronics. Through better nutrition and training, the athletes of today are becoming faster and stronger. Old records are constantly being broken, and new ones set. While the vast majority of these achievements are likely due to the athlete themselves, improvements in sports technology have also played a notable role (1). New sports gear technologies have especially been relevant to the sports of rowing, cycling, swimming, tennis and other individual and team games, giving rise not only to new records, but also the ways in which the sport is played.

Technology is not just out there in the world, on the contrary, it is inside us as well. Indeed, on any given day our bloodstreams carry the remnants of ibuprofen and multivitamins, that many individuals have been technologized, or made more technologized, through artificial hearts, contact lenses, and other medical procedures. Technology is described as any tangible, conceptual, or procedural element of modern sport and exercise science aimed at progress (2-4). The flexible definition allows everything from advancements in running shoes and eyewear to different ways of thinking about the body as technological. In the predigital age, the application of technologies in sport was heavily concentrated on athlete testing (diagnostics); improved sports equipment through better engineering and design, and utilized more at competitions. Thus, early examples of sport technologies were photo finish (1888), physiological testing equipment (1920's), the instant replay screen (1955) and first use of electronic timing touch pads for swimming (1957) (5).

Indeed, technology plays an important part in modern sport, with it being a necessary part of some sports (such as motorsport), and used in others to improve performance. The thematic applications of the technology include, sporting equipment; clothing and wearable's; facilities; competition adjudication and formats; media broadcasting and communications and performance analytics. Hence, technology and sport have had something of a rocky relationship over the years (6). Turner (7) opined that in the beginning sports and technology did not always seem like the most pairing. Considering the nature of sport and equipment use to play and with the recent convergence of technologies, many functions are fused into one small device. However, the evolution of modern icons would not be possible without the specialization and personalization of sports science, this allowed athletes develop in possible ways (5).

The game of tennis is a prime example of how nanotechnology is having an interesting impact on sports equipment. According to present research, equipment producer Wilson has been able to create tennis racquets that are twice as stable conventional racquets, and up to 22% more powerful. (8). This increase in the racquet's performance capabilities can lead to big speed increases in what is already an extremely fast paced game. In addition to racquet research, Wilson is also conducting research to find innovative ways to improve the tennis balls used today. This research has allowed them to design balls that hold their bounce much longer than is seen in balls currently available on the market. This is accomplished by bonding microscopic balls of butyl rubber with clay particles. This mixture is then applied to the inner layer of the ball, creating an airtight, but still flexible boundary that keeps the gas inside the tennis much longer. (9).

1.1 Definition of Technology :

Technology ("science of craft", from Greek τέχνη, *techne*, "art, skill, cunning of hand"; and -λογία, *-logia* is the sum of techniques, skills, methods, and processes used in the production of goods or services or in the accomplishment of objectives, such as scientific investigation. Technology can be the knowledge of techniques, processes, and the like, or it can be embedded in machines to allow for operation without detailed knowledge of their workings. Systems (e.g. machines) applying technology by taking an input, changing it according to the system's use, and then producing an outcome are referred to as **technology systems** or **technological systems** (10).

the application of scientific knowledge for practical purposes, especially in industry.

- "advances in computer technology"
machinery and equipment developed from the application of scientific knowledge.
- "it will reduce the industry's ability to spend money on new technology"
the branch of knowledge dealing with engineering or applied sciences.

2. TECHNOSPOTS :

The application of technological knowledge in the field of sports for judgement, equipments, injury prevention and performance elevation can be termed as Technospots.

Definition of Nanotechnology :

The manipulation of materials on an atomic or molecular scale especially to build microscopic devices (such as robots) Placing atoms as though they were bricks, **nanotechnology** will give us complete control over the structure of matter, allowing us to build any substance or structure permitted by the laws of nature.

So what exactly is *nanotechnology*? One of the problems facing this technology is the confusion about how to define nanotechnology. Most revolve around the study and control of phenomena and materials at length scales below 100 nm and quite often they make a comparison with a human hair, which is about 80,000 nm wide.

Some definitions include a reference to molecular nanotechnology systems and devices and 'purists' argue that any definition needs to include a reference to "functional systems". The inaugural issue of *Nature Nanotechnology* asked 13 researchers from different areas what nanotechnology means to them and the responses, from enthusiastic to sceptical, reflect a variety of perspectives (11).

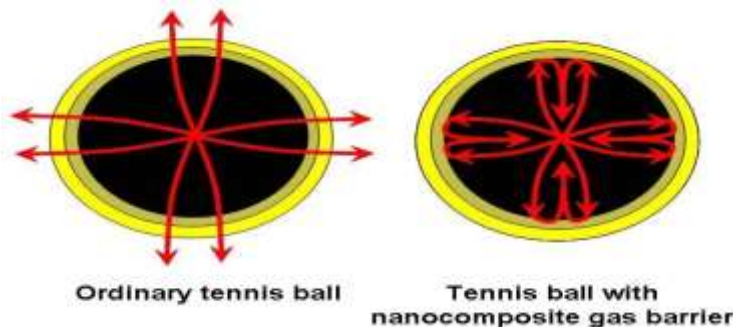
3. NANOTECHNOSPOTS:

The manipulation of materials on an atomic or molecular scale especially to build microscopic devices (such as robots) Placing atoms as though they were bricks which applied in the field of sports can be defined as nanotechnospots.

This research has allowed them to design balls that hold their bounce much longer than is seen in balls currently available on the market. This is accomplished by bonding microscopic balls of butyl rubber with clay particles. This mixture is then applied to the inner layer of the ball, creating an airtight but still flexible boundary that keeps the gas inside the tennis much longer.(4). A visual explanation of the results of this new airtight boundary is found below in Figure-1. Figure-1 Ordinary tennis ball (left) and New Wilson tennis ball coated with gas barrier (right), (12)

3.1 TYPES OF SPORT TECHNOLOGIES :

Technology is changing the face of modern sports, sports psychology and coaching. State-of-the-art technologies are used to optimize performance in sports as diverse as cycling, speed-skating, swimming, golf, skiing, surfing,



football/soccer ball, tennis racket and ball, running, facilities and many more. Technology in sport today is found in countless forms with each innovation has potentially positive and beneficial outcomes. Understanding the implications of sport technologies involve basic typology used in classifying, these are done in six types of sport technologies though not mutually exclusive, in some cases same technologies could fit into multiple categories. The categories include: self-

technologies, rehabilitative technologies, landscape technologies, movement technologies, implement technologies and database technologies. While some of the technologies are yet to make an impact on sport, understanding of many types of sport technologies help to obtain a better perspective on which technological options athletes eventually have access to and impact on sport performance (5).

A. Self -Technologies

This represents the most obvious and distributing for many people form of technology due to the potential of fundamentally and often permanently alter an athlete's physical or psychological being/make-up. Banned performance-enhancing drugs are the most recognizes of these technologies. Self-technologies encompass other kinds of athletic innovations, of which are also controversial. Others include surgical procedures, prosthetic/bionic limbs, sport psychological interventions and genetic engineering are all classified as self-technologies.

B. Landscape Technologies

This form of technology involves the sporting environment which includes the way spectators watch sport events. Prominent landscape technology is the increase of modern multipurpose sport complexes, complete with JumboTron screens retractable domes, soaring cameras, mondo tracks and artificial grass. Bates (13) argues that modern athletes have an intimate relationship with the technological sporting landscapes. Track and field athletes use new tactics because they can monitor their competitors on the JumboTrons coming down the home stretch. Sport and exercise science, like most areas of life, has been affected greatly by technological advances (14). Global positioning system (GPS) , a graph depicting the uphill and downhill portions of the terrain is also provided. Global positioning system can be used in conjunction with accelerometers to assess and monitor physical activity (15-17). As the small receivers become more affordable and accessible to the general public (in laptop computers and mobile telephones), GPS may be more widely used to assess and promote physical activity.

C. Implement Technologies

It includes equipment that athletes use or that they kick, hurl or otherwise propel. Other examples include football/soccer helmets equipped with warning devices and radios; shark suits that allow swimmers to move efficiently slice through the water and high-tech running shoes, golf clubs and tennis rackets. The interesting controversy involving these kinds of technologies is the use of fish-finding computers in sport fishing. This technology uses tools (pedometer or balance board), media (video, audio, or both), and social interaction (playing with another person) to persuade individuals to adopt the behaviour without their actually knowing it (5).

D. Rehabilitative Technologies

These are substances and procedures used to treat moderate to severe injuries make up rehabilitative technologies. They also include medicine used by healthy athletes who just want to counter the otherwise debilitating effects of their training regimens. Typically, these technologies are located in sports clinics and training facilities and are administered by specialists in athletic training or sports medicine. Rehabilitative technologies include any kind of anti-inflammatory chemical, such as acetylsalicylic acid. Rehab technologies also include whirlpool machines and ultrasound equipment that athletes use to treat sore muscles and joints. More recent developments such as electronic stimulation or slim send currents into the affected area to stimulate blood flow and aid in the healing process (5).

E. Movement Technologies

It refers to those devices and procedures that are designed to assess the form and efficiency of an athlete's body. The most common of such include videotape analysis, although there are much more sophisticated instruments that provide detailed computerized information on an athlete's biomechanics. The use of (mini) digital cameras, body-worn sensors, wireless transmission, and mobile computers has revolutionised the way coaches and sport psychologists interact with individual players and teams. Individual body-worn sensors can yield real-time biometric player data that may inform coaching decisions during a game or may be used to analyze a player progress over time (5)

F. Database Technologies

It involves computer innovations that allows athletes and coaches to know everything they need to know about their opponents and themselves. Database programmes have greatly affected the way that many and most professional coaches and players do their business. The large number of computer technology, biological engineering, new materials and energy technology, information technology, and theory of modern science and technology have been widely used in sports fields, making the face of sports and sports training environment greatly changed and improved, training methods updated, site equipment improved, greatly improved the level of competitive sport, the wide range of functions and effects of sports therefore has been fully exhibited (5).

G. Technology and Quest for Performance

Sports gear such as clothing and footwear should be user-friendly and include valuable properties such as strength, flexibility, density, thickness, durability, toughness, resistance to moisture and more importantly cost. Footwear is generally considered more for comfort and injury avoidance rather than performance enhancement, whereas clothing

such as the full body suits used in swimming are often claimed to rationalise the competitor’s performance times where winning or losing the race is measured in hundredths of a second (5).

H. Multipurpose Technologies :

Many scientific equipments are used for the purpose of judging scientific movements, correct the movement pattern based of individualised capabilities, prevention of possible injuries and rehabilitation purposes as for example the use of noninvasive application of Electromyogram (EMG).

I. Internet of Things :

Along with health-care and wellness, sports represent one of the most rapidly growing areas of personal and consumer-oriented Internet of Things technologies (IoT). These areas are in an early phase of development based on first generation technologies and infrastructures, but are destined to constantly advance due to rapid market expectations. Fans and athletes desire even more data now that sensors that measure speed, acceleration, direction, balance, distance, altitude, and stress levels have become more common, smaller and cheaper to manufacture. The technology to connect all these sensors and analyse the data they gather has also improved.

J. Open Innovative Process :

Table –I. Represent the Open Innovative Process (18,19) :

Five key elements of Open Innovative Process
1. Networking
2. Collaboration: involving partners, competitors, universities, and users;
3. Corporate Entrepreneurship: enhancing corporate venturing, start-ups and spin-offs;
4. Proactive Intellectual Property Management: creating new markets for technology
5. Research and Development (R&D): achieving competitive advantages in the market.

K. Sports fashion

The combination of sport and fashion is more widespread than ever, which is why style and design in sports goods are just as important as functionality for the majority of market segments. In this case, technology in aesthetic is an integral part of the design that focuses on the sensation and the emotion that the product evokes. Sports fashion is a fast-growing segment that is set to continue expanding in the coming years. Technology, sport and fashion have a long-standing and successful relation, which is destined to continue in the coming years.

L. Sports Industry

The sports market is an early adopting and global market in which one element is the high volume production of relatively simple labour-intensive sports goods (bulk products). This type of product is produced mainly in the Far East and in Eastern Europe (18-19, table-II).

Table II. Represent the smart sport market related to technology based products.

An emerging sports market, which is related to more intelligent and functional products that are related to more intelligent and functional products
Use of Smart materials
• Customised ductn techni New design and creativity methods New design and creativity methods ques
New design and creativity methods
Customised production techniques
Integration of ICT
Internet of things and added service

3.2 TYPES OF SPORT NANOTECHNOLOGIES :

In recent times, the sports equipment industry has emerged as a sophisticated yet commercially viable hi-tech industry where advances have revolutionized sports. Additionally, various world-level championships like Olympics and World Cups have popularized the sports equipment industry up to a great extent, making it a lucrative business opportunity for public as well as private venture capitalists.

Impact of Nanotechnology on Sporting Equipments

The degree of competitiveness in sports has been remarkably impacted by nanotechnology like any other innovative idea in materials science. Within the niche of sport equipments, nanotechnology offers a number of advantages (Fig. II) and the immense potential to improve sporting equipments making athletes safer, comfortable and more agile than ever. Baseball bats, tennis and badminton racquets, hockey sticks, racing bicycles, golf balls/clubs, skis, fly-fishing rods, archery arrows, etc. are some of the sporting equipments, whose performance and durability are being improved with the help of nanotechnology (20-23).

Nanomaterials such as carbon nanotubes (CNTs), silica nanoparticles (SNPs), nanoclays fullerenes, etc. are being incorporated into various sports equipment to improve the performance of athletes as well as equipments. Each of these nanomaterials is responsible for an added advantage such as high strength and stiffness, durability, reduced weight, abrasion resistance, etc. in sporting equipments as listed in Table- II.



Fig -III: Nanotechnology advantages in sports equipment. (Image: Wikimedia Commons)

Market Potential

Sports equipments, which are even 10-20% more enhanced in terms of performance/durability become better selling items in the market and nanomaterials may make some of the sports equipment perhaps many times better. However, despite the various advantages proposed, there is not a myriad of nanotechnology-enhanced sports equipment in the market as the technology is highly expensive and complicated to deal with.

The price of CNTs, the most common component material of nano-enhanced sporting equipments, is around US\$ 80-120 per kg7 in the market at present, which is quite expensive. Also, manufacturers will have to get new machines to produce nano-enhanced sporting goods. Sports industry personnel are still trying to figure out the actual demand of these products and how to pitch them in a right way. Most of the sporting products, enhanced with nanotechnology are sold at upper end price in the market that makes them widely inaccessible for every sportsperson (20-23).

Nanotechnologies: Nanotechnology is expected to have a huge development in sport.

NANOMETERIAL	SPORTS	BENEFIT
Carbon nanotubes	Tennis and badminton	Increase stiffness, consistency, durability, resiliency, impact, repulsion power and

		vibration control of racquets
	Golf	Reduce weight, lower torque/spin of clubs
	Kayaking	Enhance abrasion/crack resistance and easily paddling in kayaks
	Archery	Better vibration control in arrows
Carbon nanotubes	Tennis and badminton	Increase stability, power and durability of racquets
	Skiing	Decrease torsion index and facilitate transition in in skis
	Fly-fishing	Enhance hoop and flex strength of rods

NANOMATERIAL	SPORTS	BENEFIT
Fullerenes	Tennis and badminton	Reduce weight and twisting of racquet frames
	Golf	Facilitate golf club whipping
	Bowling	Reduce chipping and cracking of balls
Carbon nanofibers	Cycling	Reduce weight and increase stiffness of bicycles
Nano clay	Tennis and golf	Increase resiliency and bounce of balls
Nano-titanium Carbon nano particles	Tennis and badminton	Resist deformation and increase strength and durability of racquets, transmit more powers to shuttlecock/ball, more accurate shots
	Watercraft	Reduce weight and enhance speed of water-boats
Carbon nano particles	Road racing	Decrease rolling resistance, increase grip and mileage in tires
Nano-nickel	Golf	Increase moment of inertia and stability of clubs
Nano fibres	Several sports	Impermeable membranes for a significant increase of comfort combined with impermeable properties
Glass Nano-sphere	Sport clothing	Comfort improving

Nanotechnology is a set of sciences and technologies that allow the manufacturing and control of molecular structures and its atoms at the nanometre scale (1 billion nanometres = 1 metre).

Smart materials

Smart materials are materials with one or more properties (e.g. mechanical, thermal, optical, or electromagnetic properties) that can be varied in a predictable or controllable way in response to external stimuli, such as, for example, stress, temperature, moisture, pH and electric or magnetic fields. Over the past decade sporting goods and equipments have incorporated multiple examples of use of these materials to achieve certain functional properties. More and more these materials are also used as lower cost sensors and actuators, providing new opportunities in functional products for sports (20-23).

Classification of smart materials
<ul style="list-style-type: none"> • Piezoelectric materials
<ul style="list-style-type: none"> • Magnetostrictive materials

• Electrostrictive materials
• Thermo-responsive materials
• Rheological materials
• Electrochromic materials
• Fluorescence materials
• Smart Gels
• Biometric materials

3D printing is creating a new innovation opportunity for sports products

Over the last years 3D Printing has developed into a common technology in the design process and rapid prototyping and for aerodynamic optimisation in sports products. Companies have adapted 3D printing techniques also for wearables, shoes, and components. It is expected that these technologies will further penetrate the market allowing more personal design and shift of production locations to locations near the end user. The use for normal production of sports product for some sports gear is still limited for several reasons e.g. for strength reasons or cost reasons (20-23).

4. CONCLUSION :

Given the variety of forms of technology in sport, the topic is best approached through specific examples. Students should initially be encouraged to brainstorm technological innovations in a variety of sports. They are likely to have prior knowledge of a range of products from their own experiences. However, teachers should quickly move beyond identifying superficial lists of products that have recently been introduced into sport.. Specifically, students should understand the extent to which technological products may:

- effect participation in sport
- make sport fairer for participants
- make sport more/less entertaining for spectators
- Make global sports industries.

Due to the fast-pacing nature of technological innovation in sport, there is not a prescriptive list of specific technological and nano technological products that should be covered. Rather students should be encouraged to keep track of recent innovations and evaluate their potential impact. This provides numerous opportunities for research-based activities, which may or may not be linked to students’ chosen practical activities. The assumption is that while new products may be introduced, the issues surrounding their effects tend to be similar. While this requires ongoing teacher awareness of technological and nano technological developments specially the use of Iot in sport, it guarantees a topic area that is dynamic, evolving and relevant.

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