ZOLA Budd was born in South Africa. A quarter of a century ago, she was a teenage runner breaking the women’s 5000 m record by 10 seconds. But how does that make her special? Well, she ran barefoot!

At the prime of her fame, she was brought to Britain and sent to compete in the 1986 Los Angeles Olympics through a hasty subjugation of citizenship. Her immediate rival was the American blonde, Mary Decker, challenging her at the women’s 3000 m. They came head-to-head and when there were three more laps to go, Decker staggered from her line and collided with Budd. She fell from the track and was unable to continue but the real damage was inflicted on Budd who was wounded by a spike from Decker’s shoe.

Tears streamed from Budd’s face as she struggled to continue with the gripping pain in her tendons, fading badly at the end and finishing seventh. It was a disappointing performance, and the boos and catcalls from the American crowd told as much. Perhaps the outcome would have been different had Zola Budd been wearing running shoes.

There is also the case of the Kenyan athlete Tegla Loroupe who was unable to afford her first pair of shoes until winning a cross-country race in 1986.

Today, however, a plethora of running shoes are available to fit the requirements of different sports. Lace-up croquet shoes with rubber soles and canvas uppers went on sale in the 1860s, thanks to the discovery of vulcanisation, the process of curing rubber by the addition of sulphur. This made way for the performance enhancing studded football boots, spiked running shoes and heel-less cycling shoes.

But modern sports has progressed much beyond sporting footwear. In fact, the modern sporting gear has truly become varied and hi-tech. For instance, you have protective wear, principally applying to sports where there is a serious chance of physical injury. Cricketers are pampered with leg-guards and donning gloves.

In an age where fractions of seconds decide winners in sporting events, science and technology is truly working overtime to equip sportspersons with that winning edge that could fetch them glory.

N.S. ARUN KUMAR
Technology has also improved almost everything in sports, from training to recovery and diet to clothing. There can hardly be a muscle group that is not targeted by a sports machine that is designed to enhance bone density and ligament tensions. There are even machines that can replicate human opposition—"bowling apparatus" for cricketers and ball-launching assemblies for baseball and tennis players. Biomechanics has turned out to be a specialist area with the advent of ‘motion analysis’ tools assisted by sophisticated computer programs.

Science and technology have truly revolutionized sports today. There is no game that is untouched by this revolution. In competitions where the difference between winning Olympic medals and going home empty-handed is often measured in hundredths of seconds or fractions of centimeters, manufacturers of performance equipment seek to confer every allowable advantage on athletes. They do so through design innovations and by using materials that provide just the right combination of properties.

Some applications call for lightweight materials that provide structural support, vibration dampening, and stiffness. Other applications require materials that are flexible, breathable, and insulating, and that protect against impact, tearing, moisture, and wind.

Science in the Game

During the first test of the Australia and England Ashes series in 1979-1980, Australia’s fast bowler Dennis Lillee came to the wicket carrying a “brand-new” shining bat. When he drove the ball from England paceman Ian Botham, everybody heard an odd sound—a big clang! It was a blow sure enough to warrant a four but Lillee could run only three runs.

Australia’s captain Greg Chappell, sitting in the pavilion blamed the bat for the shortfall, and sent a new bat to Lillee as replacement. England captain Mike Brearley complained to the umpires that Lillee’s pinging bat was damaging the ball. Lillee, however, refused to obey even his captain’s instructions and the game had to stop for a good 10 minutes. The bat was...
examined and it turned out that it was Lillee’s own invention, forged out of aluminium! Lillee was ordered to complete his innings with a conventional wooden bat. Shortly after this, metal bats were outlawed through an amendment in the laws of cricket. This raised an interesting question: should games be played as per conventional laws or could science be allowed to step in?

If we look into the past history of the evolution of sports and sports-gear we see that this question has baffled many. From time immemorial, human beings have been manipulating the implements used in ball games. The Aztecs invented the rubber ball while the Australian aborigines had their own version called dumbung.

Until about thousand years ago, the basic equipments for all the ball games, the early precursors of golf, cricket, hockey and tennis, remained the same. Strangely, the earliest reference to a cricket bat is from 1624, when a fielder trying to catch the ball got hit with the bat and died because the bat was made of iron!

Similarly, by the late 19th century, tennis rackets were made from Ash wood carefully steamed and bent into a round shape. The racket strings were fashioned from sheep’s gut, which was replaced by cow’s gut after the Second World War, as they were found cheaper.

There were not worldwide regulations governing the size and construction of tennis rackets up to 1979 and so many technological innovations were experimented with including different types of woods and other alternatives.

Technology’s impact on the modern tennis game was mainly used to extend the power of shots. Metal rackets were in widespread use by the 1970s, which employed varieties of aluminium and steel. However, top-range players favoured a composite frame in which graphite was combined with a number of materials including ceramics, boron and Kevlar. The real advantage of the modern graphite racket was its greater stiffness, rather than lightness because it distorted little as it made contact with the ball.

The latest technology includes the incorporation of piezoelectric crystals into racket frames, which produce electricity under stress. The current generated by the ball hitting the strings is sent to the handle, amplified and returned to the ceramic composites in the frame. This causes the frame to stiffen and the result can be greater power and less vibration. But, there are some first class players who still prefer traditional wooden rackets.
Golf has had a long enduring alliance with technology. At first there were handcrafted clubs carved out of heavy hardwood heads of Holly or Apple trees. These leather-bound shafts continued till the middle of the 18th century right when they were replaced with metal heads. Though American Hickory had an intervening presence during the early 19th century, metal heads remained more common. This fascination prevailed to the extent that steel shafts were legalised in 1920s.

Unlike golf, however, the authorities controlling cricket, baseball and tennis resisted technological change resorting to hard-core conservatism in the case of table tennis. Cricket bats continued to look like hockey sticks until the emerging bowling techniques made it a parallel-sided willow bat. Fiercely opposing any technological innovations, the specifications of a cricket bat are now clearly laid down (Law 6) which stipulates the wooden blade to be covered with a material no more than 1.56 mm thick. Fortunately, the ‘post-Lillee’ laws leave two areas flexible: the handle of the bat and its weight. The cane and rubber handle of the traditional bat was replaced by carbon fibre with polymer insert. The material composition is made to give more weight lower down the blade making the batsmen carry an increased weight one third more than those used by the greatest hitters like Donald Bradman!

Ball of the Rings
In majority of the major games like football, cricket, golf and tennis, the physics of the ball plays a crucial part. Among the most thoroughly investigated, golf balls are most supreme and even the earliest balls were masterpieces of the technology of their days. The ‘guttee’ balls were a revolutionising attempt, which were made from the sap of the Malaysian Sapodilla tree.

Before this, there were the ‘Featheries’ made from three pieces of tough hide sewn together and then tightly stuffed with freshly boiled fowl feathers. After stitching up, the ball was hammered into shape while still wet, the expansion of the drying feathers making it very hard, later on.
Super Racing Bicycles
A number of advances have contributed to the high efficiency of the modern-day bicycle, including the development of spoked wheels, the chain concept, pneumatic tires, and accessories (e.g., seats, brake levers, and pedals). However, the two major advances are in the frame and wheels.

The use of carbon-fiber-reinforced composite frames has made the bicycles very light apart from keeping their frames stiff. Frames have recently been produced from magnesium, aluminium, titanium, and metal-matrix composites as well. In addition, hybrid frames such as carbon-fiber-reinforced composites combined with titanium have been produced.

Wheels with increased stability and rigidity for off-road bikes constructed from glass-fiber-reinforced nylon and disc wheels have been constructed. In disc wheels, discs made of aluminium alloys or carbon-fiber-reinforced composites replace the spokes in conventional wheels. Developments also include three- or five-spoked wheels for rigidity and crosswind aerodynamics.

Cycle spokes add to the drag because they whiz at twice your speed when at the top of the wheel. This is why racing bicycles often cover the spokes with a disk cover — but only on the rear wheel usually because crosswinds at the front can destabilize steering.

Futuristic Footwear
The resurgence in running brought about by the English in the 18th century meant the development of a lightweight shoe that could grip the ground. The nineteenth century saw the introduction of an all leather spiked running shoe. The need for greater speed in the modern games necessitated further refinement of lightweight shoes with improved traction.

Competition shoes made from leather fitted tightly to the foot but because they were not waterproofed the leather stretched making them useless for running.

In 1832 Wait Webster patented a process whereby rubber soles could be attracted to the shoes and boots. By the

The modern ‘Hasket’ ball came over only hundred years ago, where there was a rubber-core, a solid one, bound with rubber thread. This was enclosed in a dimpled case of ‘balata’—a type of non-elastic latex. The Hasket balls had an advantage over the experimentally introduced pneumatic balls, as they never exploded on hot days!

From about 1700, cricket balls also followed the same technology with leather sewn around a rounded hard core made out of cork, remaining a standard, unchanged through the 19th century.

Historians believe that the game of football is as old as human civilization. Chinese and South Americans kicked around something similar to a sphere, but it was not until the first rubber bladder appeared in 1862 that the game of soccer became a serious sport. Before that ‘football’ was largely an inflated animal bladder, often protected by an outer skin of leather. The first “balls” were not round, as bladders were not so, that which is still used in American Football and Rugby. However there were no regulations concerning the ball until 1872, being formulated by FA (Football Association) in England which was founded in 1863.

Strangely through the many years it passed the soccer ball changed little.

During the 1996 World Cup cricket matches, millions of viewers watched as field umpires took the aid of the third umpire before taking a decision on close run-outs and stumpings.
The dramatic effect of technology is more evident in pole-vault when bending bamboos were replaced by Aluminium in 1957.

Apart from adding a layer of cloth between the bladder and leather casing everything remained the same. The modern alteration was the interlocking panels replacing the traditional 18-section exterior of stitched and tanned cowhide. The main problem was the leather balls absorbing water in damp conditions, becoming heavy and making “heading” a dangerous exercise.

In modern balls, movement in straight line is preferred to added distance. The number, size and optimum spacing of dimples along with the weight of the hardcore was found to affect distance travelled, whereas a three-layer ball with a polyurethane exterior created a low flying and slow spinning ball. When the physicists went on to work on the football, FIFA – the international body controlling the game – eagerly established a standard size, pressure, shape retention and bounce and weight characteristics for it. Coloured balls were permitted for the benefit of TV but it regulated the materials from which it could be made.

The first synthetic (Polyurethane) ball was used in World Cup 1986. The maximum permitted weight gain through moisture absorption was fixed as 10% but the 2006 World Cup ball never gained more than 0.1% of its weight. The improved water resistance was achieved by replacing the traditional stitching of the panels with thermal bonding. The much-evolved modern first-class football also has surface interruptions to maximise the friction between itself and the boot. The number of panels also has been reduced, from 32 to 14.

The Winner’s Fabric

Sporting apparel first came to the field in the form of protective wear. In cricket, the batsman was wearing ‘legguards’ even from the days of the 19th century. But, the technology was basic involving canvas, leather, horsehair, and wood enforced cotton paddy. Wicket keepers often laced the inside of their gloves with meat to protect their hands. Footballers took to wearing shin-pads, especially players of American football. Helmets were worn by some since the 1890s and it became compulsory by 1930s, but nothing for the head of cricketers, as the England batsman Derek Randell ironically put it, when hit by a ball on his head, “No good hitting me there mate, Nothing to damage!”

The majority of man-made sports-wear appeared for the first time after World War II. Rayon and Nylon paved the way for acrylic (1950), Polyester (1953), Spandex (1959) and more recently Lyocell in 1992, which is claimed to be environment friendly. The first advantage of technologically produced fabrics is weight, especially when wet. Traditional natural fabrics like wool, cotton and even Nylon are hydrophilic in nature.

On the other hand, Polyester, which is the main ingredient of most of modern sports garments, is very much hydrophobic, that is, it does not absorb water. According to sports physicians, wet fabrics could have serious implications such as hypothermia when the body is unable to generate sufficient warmth or can induce wasting of energy. Even Polyester has a clear disadvantage of building-up body temperature in hot conditions.

Technology had several answers for this, the most popular being “breathing fabrics” sold under the name “Core-Tex” and “PB2”. Simply speaking, they are impervious to rain but allow moisture (sweat) to pass through. Their effectiveness in shifting moisture from

The father of the modern running shoe was Adolf Dassler who began making shoes in 1920. By 1936 his shoes were internationally acknowledged as the best and were worn by athletes of the calibre of Jesse Owens. Dassler’s running shoes were worn at the Berlin Olympics. Dassler specialised in shoes designed for sport. After the lean war years he continued to progress and developed the training shoe made from surplus tent canvas and rubber from fuel tanks. In 1948 he founded Adidas but the company was soon to split into two. In the 1970s science began to take a much bigger role, as manufacturers involved podiatrists (foot experts) in their product development. Nowadays modern synthetic shoes are made of lightweight mesh fabric uppers and lightweight synthetic soles chosen for maximum flexibility and comfort. Running shoes have no heel and this provides the necessary leverage for toe spring, which propels the runner’s legs forward.

Whether it’s foam, silicon, air or gel, cushioning systems have become one of the most important aspects of the modern running shoe. The 70s saw the development of ethylene vinyl acetate (EVA) - a substance made up of millions of tiny air bubbles that provides cushioning and absorbs shock. It was considered to be a major advance in footwear technology and is still widely used today.

And now space age shoes are also here. The smart shoes have a liquid crystal display system. When plugged into a personal computer they can tell the distance covered, time taken and the calories burned after each run!
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inside to out is measured as MVT (Moisture Vapour Transfer).

The latest technology in sports-fabric is however PCM-fabric made from "Phase Change Materials." They usually incorporate highly hydrophobic fibres like ‘Ingeo’ or ‘Olefin’. Worn next to the skin as “under armour”, they help keep the body at constant temperature, cool in hot conditions and warm in cold climate. The material remains in the gel-state and when they attain a high temperature, they change the ‘phase’ by absorbing the heat. When the temperature around them falls, they release their stored heat and return to the gel state.

Another virtue of modern man-made fabrics is that they can be quick wicking, that is, capable of soaking in sweat and removing it from the body. An athlete can feel more comfortable with a wicking garment and moreover with some anti-microbial element it can combat fungal infections too.

It would not be an exaggeration to say that technology of sports clothing could even enhance fair play. A shirt made up of Spandex material can stretch up to 600% and when the defender is blocked by grabbing his shirt, there is greater chance of the referee seeing it, which could run only three runs.

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Then there is the Snickometer, a technological assistance provided to umpires and commentators that makes judgment easier. It was invented by the computer expert Allan Plaskett. The working is based on sounds picked up by microphones located in the stumps or pitch, which is reproduced as an oscillation chart, depicting the ball passing the bats. Useful in LBW related disputes.

Hawkeye is a British invention derived from missile-tracking technology that is used to recreate the trajectory of a moving ball with 99.99% accuracy. It works on a set of six wirelessly linked cameras, set in different positions in the playing area. With the help of a computer program, it can also predict the path of the ball, if it goes uninterrupted. ‘Skyscope’ also functions similar to Hawkeye.

Many of us have wondered over the amazingly detailed statistics flashed upon our TV Screens, for example – ‘Distance covered by ‘X’ during the match is 8,426 m’. Such wonders have been made possible through sports-tracking systems like the well known ‘Pro-Zone’. Here, an array of digital cameras tracks the movement of the ball and each player behind it. The impulses are then fed to a computer system that gives positional breakdown every 0.01-second. This means that coaches, experts and players can recall almost everything of the overall performance. This type of video playback is now widely used for skill improvement also. Top performers are filmed demonstrating a skill, which is broken down to analyse its style and tactics. An example is “Sports Wizard” developed by Dartfish.

The automated boxing scoring system (ABSS) is a research and development project being developed by a group of Australian institutions and private companies. The system uses wireless communication, micro sensors, smart integration, and computer scoring to encourage accuracy and safety in boxing. The system allows monitoring of performance in real-time and is able to indicate the location of hits, display basic statistics on hit locations, and show the current score of each boxer.

There is no doubt that technology has been changing sports, from the moment toe-hold groves were inserted in ancient Olympics to the potentially revolutionary “dee-three-oh” protective ski clothing. But more than that the nature of sports itself is changing. Over the last 20 years, sports has evolved into an industry.

Scientists, engineers, technicians, trainers and coaches are striving to give their athletes a slight edge, that could make the difference between winning a medal and going back empty handed.

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