The Evolution of Soccer: How Technology Changed the Game

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Introduction

The evolution of soccer equipment has changed a ton through modern technology, changing a player's performance on the field and how games are determined based on sensors applied on the field and on any type of wear that professional players may have, which has impacted the overall style of the game. A little background understanding of how soccer began starts all the way back in England in 1863. It originated from a game called cuju, played in ancient China, that involved kicking a small ball into a small net, but this sport wasn't identified as soccer until 1863. Which later on got spread all across Europe and kept spreading throughout the world until it became one of the most-watched sports.

The research gathered for this paper mainly comes from multiple sources, such as sports journalism, Official FIFA Articles, and technology publications. The main point of the research was to find sources that focused on the different topics mentioned in my paper. First, sources that helped me explain how soccer equipment has evolved from the start, all the way up to modern day. And other sources helped me explain the timeline. Finally, I used sources that explained how certain technologies were used and how fans reacted to them. Overall, all these sources help me explain the topic of how technology has changed the game of soccer.

Old Soccer

Soccer wasn't always this fancy sport with all this modern technology. From the start, all the equipment needed for the sport was simple, accessible equipment. For example, in old times, the ball used to be made out of leather. The shoes that people used to play soccer with were just regular boots. And for goalkeepers, who are usually the only players on the field

who are able to guard the net with their hands, but are limited to a small box around the net, are there to prevent any player from scoring. In the past, goalkeepers were limited to equipment, so they used to block fast travelling balls barehanded or sometimes used gardening gloves.

All these things back then were uncomfortable to play with, but people didn't mind because they had an immense amount of passion and love for the sport. But as time passed and soccer kept evolving with its equipment, players were receiving better-looking equipment, but soccer became more robotic because the players didn't care about doing skillful moves and entertaining the audience. They only focused on making sure their stats were above average.

Evolution in Soccer Balls

After better quality technology, such as material and sensor chips, was introduced to the sport in the late 1800s, players started to gain access to better equipment, such as soccer balls and cleats. In 1855, Charles Goodyear improved the balls by making them out of different materials, such as vulcanized rubber, which created inspiration for other people to evolve the soccer ball. In 1863, the English Football Association was formed, and in 1872, they announced that the ball must be perfectly spherical with a specific weight and circumference. On the official TheFA website, I found the exact requirements for a ball to be legal for matches. The article stated that the ball must be: " spherical, made of suitable material, have a circumference of between 68 cm and 70 cm, weigh between 410 g and 450 g, and have a pressure of equal to 0.6 - 1.1 atmosphere at sea level." This forced all companies to make a ball that met all these requirements because if they weren't meant then the ball

wasn’t eligible to be used in official matches. In the 1950s, white and orange balls were introduced. The reason why balls were made in orange and white colors was to improve visibility during certain conditions, such as night games and games that were played while it was snowing. In 1970, a new ball was introduced; this time, Adidas was the creator and introduced the “Telstar” to the players and audiences. The Telstar ball was made for the Mexico World Cup, and what made the ball unique was its 32-panel Buckminster design, which contained 20 white hexagons and 12 black pentagons. The main reason this ball was designed was for television watchers. It was to enhance the visibility of the ball for black and white television. Later on in a couple of years, in 1986, the “Azteca” ball was introduced. This was a huge moment in the soccer world because it became the first fully synthetic, polyurethane match ball. What made it so unique and evolved was the material itself. The material it contained would completely stop water absorption, which meant it maintained the ball's light weight in any wet conditions. After this, companies decided to make it a next-level ball by making balls futuristic for their time.

In 2004, all the way up to the present. Companies decided to take all of this to the next level by enhancing real technology inside the ball. First, what changed was the stitching; the stitching was replaced by thermal bonding to create clean and perfectly round spheres. Then microchips were inserted into the ball, which allows the administrators to collect data such as real-time speed, spin, and offside data. Once this new tech was introduced, many footballers felt mixed feelings about it. Some people saw it as unnecessary and took out the adrenaline from the game, while others said that it made the game even more fair.

But honestly, it had its pros and cons. Many people argued that this new adapted technology took away the excitement of the sport and made it more of a following rules by

the book type of sport. There would be times where a goal wouldn't be allowed by a centimeter of a player being offside, disallowing the goal, and that took away the fun in sports because back then, referees wouldn't disallow goals that were a centimeter offside. It was only if the player was clearly offside. And fans would only say it was a good adaptation into technology when it would favor them in goals. But when it wasn't in their best interest, people would say the new adaptation of technology wasn't useful and was killing the sport.

The technology was initially tested by engineers in order to make sure it was functional. They began by finding a suitable sensor that could collect data from the players and send it to administrators as fast as possible, as well as fitting into the ball. After doing so, they inserted a 14-gram package that contained an inertial measurement unit and an ultra-wideband transmitter. And the way they would collect data, such as every touch, pass, and collision, was by the sensor transmitting data 500 times per second to a Local positioning system antenna, which would be installed all around the stadium. Engineers believed that there was a better placement to put the chip in, so for the 2026 Trionda ball, engineers evolved their design by inserting the chip onto a side panel instead of the dead center. The reason for this was to keep the ball balanced and to prevent it from wobbling in mid-air.

Evolution in Soccer Cleats

The second piece of equipment that was also improvised in the late 1800s was soccer cleats. As I had mentioned before, people used regular boots to play soccer. But as the ball kept getting improvised, people believed that they should also improvise soccer cleats alongside the balls.

This time, it was more of a DIY by the players. What I mean by this is that players felt as if there wasn't much traction on shoes, so they started hammering metal nails into the soles of their shoes to gain better traction on muddy fields. In 1954, Adidas released the very first modern football cleats. What made these the first modern cleats was the light build, non-leather sole, and the shoe had screwable plastic and rubber studs. These shoes were only meant for the sport. It shifted its focus from protection to performance and acceleration completely.

In the 1960s, companies started to lower the height of the boots from the ankle to allow players to have better flexibility and ankle movement. Later on in the 1970s, brands such as Adidas introduced synthetic materials that made cleats lighter and stronger. They called the cleat the "Iconic Copa Mundial." Made out of Kangaroo leather for superior performance and flexibility. Then came 1994, which was called the "era of control'' for cleats. This was because Adidas released the well and famously known Predator cleats. These cleats were designed by Craig Johnson. Having rubber fins on the upper part of the cleat, it was specifically designed to improve ball control, spin, and accuracy in every kick. It was focused on improving every player's stats.

At this time, Adidas was the biggest and only cleat company in the game to satisfy all players, but later on in 1998, Adidas gained competition from Nike, which entered the market by showcasing the Mercurial Series. During this time, Nike took the spotlight due to the flashy cleats they made, which won them the "Era of speed." The reason why these cleats became so popular was that they were worn by a well-known Brazilian legend, Ronald. These cleats got their inspiration from track spikes, making Nike incorporate the same idea into

soccer cleats by using thin synthetics to make the cleats weigh 200g. Prioritizing speed over anything else.

In the 2010s, there was a huge change in the cleat industry with brands changing to knitted one-piece uppers. Brands such as Nike and adidas created Nike Flyknits and adidas Primeknit. The reason for this design change was to make the cleat similar to a sock-like fit to eliminate the need to break in cleats for a long period of time before being able to play in them comfortably.

Lastly, in the present time, modern cleats have received the same upgrade as the soccer ball by using lightweight materials such as carbon fiber in the sole plates and partially built-in tracking technology. What makes this special and useful is that the data is collected. The sensors collect data and send it through Bluetooth to a smartphone app right after a match. It's useful to players because it tracks their physical data, such as their top sprint speed, total distance run, the number of times they touch the ball, and food dominance. This technology is also useful to coaches because it gives them data from each player on their teams and allows them to prevent any injuries and improve any weaknesses a player may have.

GPS Tracking Vests

But these two are just the tip of the iceberg. Another piece of technology that helps players is a GPS tracking vest. Basically, what it is is that it's a vest that players wear under their jerseys, and this vest contains a small, powerful pod that is placed between the shoulder blades to hold it in place, and it records an athlete's physical metrics. This pod collects similar data to the cleats, but this sensor also tracks each player's health, making the tech a bit more advanced.

The vest was originally introduced in the late 1990s to early 2000s. Initially, athlete tracking technology was adapted from military and aerospace technology. It was already being used in other sports, but innovators believed that this technology could also be used in soccer. Then, from 2007 to 2010, these vests were introduced on the pitch. Companies like Catapult Sports started making and selling wearable, custom vests to hold GPS pods. After, Certain teams in the Premier League started to use these vests for players during training to track their players' max speed and distance. The following year, from 2011 to 2015, the tracking vest became a huge thing, and the tracking pods later on became capable of showing live results. Meaning coaches could see each player's heart rate, their acceleration, and deceleration. From 2015 to 2020, there was a proposal sent to the IFAB (International Football Association Board) to allow technology use in real-time matches, and after some review, the IFAB approved the use of technology and tracking systems during official matches. This allowed coaches to track each player's fatigue and to make sure they make the right substitutions in real-time matches.

Goal Line Technology

Another huge piece of technology that is used and has impacted the world of soccer is goal-line technology. What it is is an electronic system that is placed near the goal net, containing 14 high-speed cameras, 7 for each net, mounted onto the roof, and is used to collect signals on whether the ball has completely entered the goal net or not. Allowing refs to allow goals accurately.

The Goal Line Technology began due to many official matches having close goals that nobody could tell whether they crossed the goal line completely or not. Still, due to there being nothing to confirm it, such as different camera angles or sensors that allow referees to make the correct decision, it forced FIFA to reconsider technology aid to limit any unfair goals. An example of this was a disallowed goal from England vs. Germany in the 2010 World Cup. There was a huge debate about whether it should have been a goal, which led to consideration of bringing new cameras and sensors onto the field.

In 2011, FIFA began to test prototypes and different types of systems to ensure accuracy in its Goal Line Tech. Later on in July 2012, the IFAB voted to amend the laws of the game to allow Goal Line Technology into the world of soccer. After being allowed in December of the same year, it was used in an official FIFA tournament. The Club World Cup in Japan, during this tournament, used Hawk-Eye and GoalRef systems. What they are is the Hawk-Eye is just camera angles that allow us to see the line from the top of the line. The GoalRef system is a sensor that goes from post to post that allows referees to be informed whether the ball has completely crossed the line. After the whole tournament went through with the Goal Line Technology, FIFA considered this a success and went on with keeping this equipment. After a year in 2013, other leagues, such as the Premier League, witnessed this

technology at the Club World Cup; they embedded this technology into their league, and it was also a success.

After FIFA saw that the new technology was working in all the leagues that were using it, they decided to debut this technology in the 2014 World Cup. It is considered one of the biggest tournaments in the world because it's the only tournament in which countries play against each other. There are only 48 spots, meaning not all the countries compete in this tournament. But what makes this tournament the most famous amongst all the other tournaments is that it only happens every 4 years. The way to decide which countries are chosen to play in it is by nations competing in continental qualifying matches throughout the 3 years before the World Cup. The only nations that get automatic qualification are the hosting nations. And since the World Cup is considered the biggest tournament, FIFA announced Goal Line Tech with a new type of camera. The GoalControl-4D cameras confirmed all the goals that were hard to tell by eye. Then, from 2015 to the present, the goal-line technology became a standard in all pro European leagues and major tournaments. And the GLT itself keeps evolving by getting improved with better cameras and AI to improve its speed and accuracy, which is used with VAR (Video Assistant Referee), which was introduced in 2018. This technology has improved a ton that now in modern day the system sends a signal to the referee's watch within one second. Giving the referee the goal or no goal.

Audience's reaction

Initially, audiences felt a bit frustrated about the introduction and evolution of soccer balls. People felt a way towards it because many goals were disallowed, and many of the goals were disallowed because the sensor ruled out goals that were offside by mere

millimeters. Many people expressed their thoughts on it, and they said that this new technology frustrated them by the overturning of goals due to small margins, and they felt as if the human element of the sport was being taken away from the sport, making the sport less hyped. And if new technology keeps getting introduced like this, then what would be left of the sport? And what would soccer look like without the “Human Element”?

Afterwards, the thoughts and reactions on GPS tracking vests and smart cleats were similar but different from smart balls because the fans believed that this would be a good tool and assistance to players. They didn’t really see it as something that affected the sport. Fans viewed this as a positive tool because it would prevent big players from getting injured and keep them on the field during important matches. An article that also demonstrates how the vests are used and how useful they are for multiple sports is the HUDL Article. It talks about the different things that the vest is helpful with, from tracking to preventing injuries, and shows how much money teams spend on players' injuries.

Lastly, The Goal Line Technology. People surprisingly took this as a positive and one of the best tools to be introduced in soccer. The reason why it’s surprising is that people didn’t have a good reaction to the smart balls. But people liked this GLT because it’s seen as a system that makes quick and accurate calls without slowing or pausing the game. And this system received a ton of praise from fans.

Conclusion

Overall, the growth and evolution of soccer has come a long way from simple leather balls, all the way to the present modern day, where balls have chips within them that allow them to collect data around them. And the same can be said about cleats, GLT, sports

equipment such as GPS tracking vests, and many more. But even though each piece of equipment has its pros and cons, and fans have expressed their emotions and thoughts on it, we can all agree that these changes were made to make it fairer for everyone. And I think the only thing that soccer can continue evolving in is balls and cleats. I think that all the technology and systems used to identify goals and offsides are the peak of the use of technology in soccer. But without a doubt, soccer will always keep evolving, since technology is constantly improving, so will the tools alongside it. But even after everything changes, audiences and fans will continue to have an immense love and passion for the sport.

References

Bishop, J. (2015, December 15). The 91st: Pros and Cons of Goal-Line Technology. *Orlandocitysc*. https://www.orlandocitysc.com/news/91st-pros-and-cons-goal-line-technology

Bundesliga. (2020, March 18). *The history of soccer*. bundesliga.com - the Official Bundesliga Website. https://www.bundesliga.com/en/faq/all-you-need-to-know-about-soccer/the-history-of-soccer-10560

FIFA. (2015, June 4). *Breaking down Goal-Line Technology* [Video]. YouTube. https://www.youtube.com/watch?v=m17ERc-kQhQ

FOX Sports. (2024, June 28). Cutting-edge technology at Euro 2024 is changing the face of soccer. *FOX Sports*. https://www.foxsports.com/stories/soccer/cutting-edge-technology-euro-2024-changing-face-soccer

Golden Shoes Soccer movie. (2013, October 14). https://goldenshoesmovie.com/the-history-of-soccer-cleats-part-2/

Ltd, D. S. P. (2025, February 10). *The evolution of the soccer ball*. Deploy Football. https://deployfootball.com/blogs/news/the-evolution-of-the-soccer-ball

SeoAnalytics, A. (2025, February 28). *How soccer equipment changed over time | Complete timeline*. Goal Kick Soccer. https://goalkicksoccer.com/blogs/news/how-soccer-equipment-changed-over-time

Simulator, V. S. (n.d.). *Unleashing Soccer Potential: How wearables and technology are transforming cleats and player performance*. VersusSportsSimulator.com. https://www.versussportssimulator.com/articles/unleashing-soccer-potential-how-wearables-and-technology-are-transforming-cleats-and-player-performance

Smolski, M. (2021, January 21). *Are Soccer vests worth it? 5 Benefits and Negatives to Consider*. Playermaker. https://www.playermaker.com/blogs/our-blog/are-soccer-vests-worth-it-5-benefits-and-negatives-to-consider

Sparkes, W., PhD. (2025, February 5). *How wearable technology elevates elite football performance*. Hudl. https://www.hudl.com/blog/wearable-technology-in-sport

Sports, G. (n.d.). *The evolution of the soccer boot*. GSI Sports. https://gsisports.com/the-front-post/f/the-evolution-of-the-soccer-boot

Why do Football Players wear GPS vests? - Catapult One. (n.d.). Catapult One. https://one.catapultsports.com/blog/why-do-soccer-players-wear-gps-vests