The Reciprocity of the Evolution of Sport and Technology

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Brian Lembo

Spring 2020

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Advisor

Sean M. Ferguson, Department of Engineering and Society

Introduction

Since the inception of sport, technology innovation has been implemented by individuals and organizations in pursuit of a competitive advantage. The early adoption of technology innovation in sport focused on areas of technology that were "easy to integrate and essential to the performance of the sport, such as cycling or rowing." (Ringeut-Riot, Hahn, & James, 2014, p. 1) These technologies were more narrowly concerned with the mechanical properties or applied sciences of the sport, such as the frame material used or the shape of the boat. Where previous applications concentrated on basic engineering to enhance sport performance, newer technology innovations have additionally evidenced a greater understanding of sports science and medicine expertise. () No matter the need, technology has adapted to meet sport demands over the years; however, the extent to which technology has progressed poses a threat to sports. Unlike the collateral effect to humans of robots being introduced to factories and replacing jobs, technology has a direct impact in sport on the user(s) under consideration. In the example of robots in factories, the humans are replaced, but the quality of the product or service remains constant, if not better. In sport, technology is aimed at making the user's life easier and therefore takes away from the quality of the athlete as they are no longer tasked with the challenge of performing a specific skill. This very concept of technology compensating for athletes' abilities is threatening to the integrity of playing sports.

Nevertheless, some sporting organizations approach adoption of new technologies with apprehension as they strive to preserve the traditions of the sport. (Ringeut-Riot, Hahn, & James, 2014) Considering the degree of technology nowadays, the latest gadgets can substantially alter the ability required to perform a skill or action. At the same time, humans demand technology innovation in sport to achieve a competitive advantage over their opponents as they strive to

achieve maximum potential. The interactive relationship between the inherent "survival of the fittest mentality" of humans and technology innovation disrupting the landscape of a sport is reciprocal. As athletes master one piece of equipment, they demand a newer, improved one and as the demand for new equipment increases, as does technology innovation. The way that technology in sports develops, rather than its very existence in sport, can raise ethical problems. (Miah, 2007) Of critical value is to understand how a range of technological systems affects social practices and, in the terms of sport, influences progress. (Miah, 2007)

In this research paper, I will analyze the iterative relationship between the evolution of a sport and the subsequent implementation and advancements of technology. I will provide context about the sport of golf itself, focusing on the equipment, regulations, professional leagues, and governing bodies to set the current landscape of the sport. Then, I will explain in greater detail the incremental changes in equipment, "technologies", that have been focal points of attention surrounding technological advancement in sport. In order to highlight the effects of these advancements, I will utilize the Distance Insights Report (DIR), released by the current governing bodies of golf every year to provide research and analysis on the effects of hitting distances in the sport, to formulate trends about how technology innovation directly affects the sport of golf.

Literature Review

Modern Golf

The sport of golf has been played by amateurs and professionals for centuries throughout the world. Modern golf is played outdoors on an 18 hole course with one to four people in a

grouping. The first nine holes are known as the “front nine” and the second nine holes are known as the “back nine.” The objective is to hit the ball from the tee box (location where you tee off), onto the fairway (short grass meant for hitting off of), onto the green (very short grass meant for putting on), and into a hole on the green in as few strokes as possible. Every course, and every hole on every course, is given a score to “par”, which is the standard amount of shots you should take in a round, or hole, of golf. The scores to par for a course typically range from par 70 to par 72 and the score to par on each hole ranges from par 3 to par 5 and are based on the relative lengths of the holes. The number attached to the par is the number of shots that should be taken on a given course, or hole. Surrounding, the tee box, fairway, and green is taller grass that is much harder to hit a ball cleanly out of, referred to as “the rough”. Other obstacles on the golf course may include, but are not limited to, bunkers (holes dug into the ground and filled with sand), fescue (weeds that grow so tall it is seemingly impossible to hit out of them or even find a ball), rivers, lakes, or streams. (Goodner, Gillmeister, Moran, 2020)

Today, there are professional golf leagues in many countries throughout the world. The most prominent and well known league is the PGA Tour, which mostly hosts tournaments in the United States and features the four major championships of golf: The Masters, The US Open, The Open Championship, and The PGA Championship. While the PGA Tour was originally established by the Professional Golf Association (PGA) of America as a separate organization for golf professionals, today the PGA of America is primarily focused on helping golfers of all skill levels further their passion for the game and navigate their golf journey so that they can take it as far as they want to go. (Whaley, Richerson, Lindert, n.d.) Although the PGA Tour plays a crucial role in promoting and upholding the rules and traditions of the sport, the Royal & Ancient

Golf Club of St. Andrews and the United States Golf Association "govern the sport via a global set of playing, equipment, handicapping, and amateur status rules." ("About the USGA," n.d.)

Governing Bodies

Two governing bodies work hand-in-hand overseeing the sport of golf: The Royal & Ancient Golf Club of St. Andrew's (R&A) and The United States Golf Association (USGA). The R&A was founded in 1754 by a group of golfers who played at the Golf Club of St. Andrew's located in Scotland and adopted a set of rules that was nearly identical to those set forth just a decade prior by the Edinburgh Gentlemen Golfer's rules. (Goodner, Gillmeister, Moran, 2020) As the sport of golf gained increased popularity and golfers became more skilled, the R&A became, by common consent, the oracle on rules in the sport and, in 1919, accepted the responsibility of managing the Open Championship (formerly known to Americans as the British Open), one of the four major championships in professional golf. (Goodner, Gillmeister, Moran, 2020) The first proof of golf as an organized game in the United States was the founding of St Andrew's Golf Club, named after the Golf Club of St. Andrew's in Scotland, in Yonkers, New York, in 1888. Other early courses were erected around the country in the late 19th century and clubs began hosting their own invitational competitions, calling them championships. Controversy arose over the validity of these "championships" because the competitions were based on invitation and hosted by a single club. As a result, the USGA was created in 1894 with the objective of creating a set of rules for the game and organizing amateur and open championships. In 1895, the US Open, US Women's Open, and US Amateur Open championships hosted their inaugural tournaments. (Goodner, Gillmeister, Moran, 2020)

At the time of their founding, golf clubs operated more similarly to today's governing bodies of golf (USGA and R&A) whereas contemporary golf clubs act more like social clubs.

Golf clubs were previously able to act more independently in setting rules and hosting events than they are today, given that no central governing body for overseeing the sport existed.

As a collective unit, the USGA and R&A oversee the single set of playing and equipment rules that are enforced globally. The central focus of their partnership is to define and protect the challenge and character of the sport of golf so that it may flourish long into the future. The Rules of Golf state the fundamental principle that "golf is a challenging game in which success should depend on the player's judgment, skills, and abilities." ("Distance Insights Report," n.d.) The Equipment Rules seek to "protect the traditions of the game, to prevent an over-reliance on technological advances rather than on practice and skill, and to preserve skill differentials throughout the game." ("Distance Insights Report," n.d.)

Technology in Golf

The sport of golf has experienced more controversy over equipment than arguably any other professional sport today. Due in part to its relatively long existence and the variety of equipment used over that time, the sport of golf continuously experiences the introduction of new technology and the governing bodies are tasked with monitoring these technologies so that the core principles of the sport are not undermined. (Ringeut-Riot, Hahn, & James, 2014) This interaction between the advancement of technology and the progression of the sport of golf has taken on countless forms.

Historically, golf has been referred to as a "stick and ball" sport which tends to undermine how vital the role of the golf ball has been in the evolution of the sport. Early adaptations of the golf ball were spherical wooden balls and small, leather stitched handballs filled with hair. (Laird, n.d.) The history of these primitive technologies, however, remains

shrouded in question as little primary evidence has been found of either. The golf ball that first came into popularity, the “feathery”, was constructed from hard leather sacks that were filled with feathers to form the shape of a ball. During manufacturing, the feathers and leather were wet so that as the ball dried, the feathers expanded and the leather shrunk, creating a tightly packed ball. (Laird, n.d.) While all previous installations of the golf ball were smooth and round, the “gutty”, made of gutta-percha gum resin, incorporated notches on the golf ball as golfers noticed notches, or blemishes on the ball, increased ball performance. The gutty quickly replaced the feathery as the most widely accepted golf ball, but its use was cut short. (Laird, n.d.) The “haskell” was developed, making way for all future golf ball innovations. The haskell was constructed of a solid core tightly wound by rubber threads and covered by a gutta-percha layer. The outer layer was notched in different patterns. Dimples that optimized the haskell ball’s control and distance were not introduced until a few decades later. Although the gutty was first introduced in 1902, the ball would not be replaced until 1967, when the sports equipment manufacturer Spalding recreated the gutty construction using a Suralyn covering. Laird, n.d.) Since the inception of the gutty, golf has experienced an outbreak of golf ball developments consisting of one, two, and three layer core designs and variations of dimples and covers.

The contemporary golf club came to be when British politician, Robert Forgan, exported American hickory trees to Scotland in 1826 to manufacture shafts for a club. (“The Evolution of the Golf Club,” 2018) Due to its availability and durability, hickory became the standard wood of choice for club makers. At the time, persimmon wood was widely utilized for club heads until the late 19th century, when manufacturing processes advanced and iron heads could be mass-produced and implemented. Further, as production speed and efficiency increased with the progression of manufacturing technology, steel shafted golf clubs were introduced to the sport in

1922 and quickly gained interest from golfers at all levels. (“The Evolution of the Golf Club,” 2018) During the middle of the 20th century, other alterations to the golf club were not as significant, as incremental changes were made in material or solely to specific clubs. Examples of this are evidenced by the development of the modern sand wedge in 1932 by Gene Sarazen and the implementation of lightweight graphite shafted clubs in 1973. (“The Evolution of the Golf Club,” 2018

At the end of the 1900s and carrying over into the new century, the sport of golf experienced immense development of newer, more effective technologies that significantly enhanced performance. Persimmon headed golf clubs were quickly rendered obsolete after the golf equipment manufacturer Callaway released its Big Bertha driver in 1991. The Big Bertha Driver implemented a stainless steel club head. Following the Big Bertha, equipment manufacturers experimented with oversized titanium driver heads, varying spring-like effects and moments of inertia of the club head. (“The Evolution of the Golf Club,” 2018) In the early 2000s, hybrid clubs, which incorporate the design from both an iron and wood, were introduced to the game, allowing less skilled players to use a club alternative to that of the harder to hit longer irons. The newest trend in golf club innovation is the adjustable driver head which enables players to adjust the weight and loft of their driver. This adjustment allows players to personalize their club to optimize ball control and distance. Adjustable drivers were first introduced to golf in 2013 by Taylormade, a golf equipment manufacturer, who released the R1 Driver that could be adjusted to 12 different lofts and 7 different face angles (“The Evolution of the Golf Club,” 2018).

Distance Insights Report

Every year, the R&A and USGA work together to conduct and release a Distance Insights Report (DIR), which is a comprehensive research report on the contributors to hitting distance in the sport of golf. Further, the report helps provide an understanding on the past, present, and future implications of distance on the sport by presenting data and analysis on the evolution of hitting distances, the factors which impact hitting distance, trends of golf course lengths, and the impact of increases in hitting distance and golf course lengths. ("Distance Insights Report," n.d.) The most recent DIR, released on February 4, 2020, "features more than 100 years of data, informed by a library of 56 supporting documents" and concludes with the governing bodies' perspective on the implications of their findings. ("Distance Insights Report," n.d.) The key finding of the 2020 DIR was that hitting distances and golf course lengths have been increasing over the last 100 years. The USGA and R&A believe this recurring cycle has adverse effects on the long-term future of the sport for two main reasons.

Firstly, the "inherent strategic challenge presented by many golf courses can be compromised," ("Distance Insights Report," n.d.) especially courses that cannot be extended to keep up with golfers who play from the longest tees. As golfers continue to achieve greater hitting distances, they will require less variety, length, and creativity of shot types on the same length courses and holes, which inherently undermines the core principle in golf of using a wide variety of skills to make risk-reward judgements throughout a round. Today, even the most challenging and thoughtfully designed courses are becoming much easier to complete and, arguably, obsolete due to golfers' emphasis on hitting distance at the expense of other attributes. Both widely renowned and less well-known courses are experiencing increased risk of becoming less challenging, or even obsolete, for those who play the longest tees.

Secondly, the lengthening of golf courses has its own adverse consequences that affect golfers at all levels and the game as a whole. ("Distance Insights Report," n.d.) The development of new golf courses as well as the expansion of existing ones require significant capital investments and higher annual operating costs. Further, the trend towards longer courses puts golf at odds with growing societal concerns about water use, chemicals, and other resources, the pressure for development restrictions and alternative land use, and the need to mitigate the long-term effects of a changing climate and natural environment. ("Distance Insights Report," n.d.)

The USGA and R&A believe there is an unnecessary emphasis on hitting distance and expectation that future generations will achieve greater hitting distances than previous ones. Further, they claim that golf's fundamental character and skill challenge do not depend on the length of a shot nor the length of the course.

Discussion

The interplay between technology innovation and sport can be seen as an iterative process. As new technology and equipment are introduced, governing bodies must continuously evolve and modernize the rules to accommodate the technological climate while preserving the traditions of the sport. Nowadays, technology and innovation are integral to every aspect of athlete development and performance. (Ringeut-Riot, Hahn, & James, 2014) From training, to health, to studying film, to performing, athletes are now connected to the Internet of Things (IoT) at almost all times. As mentioned previously, golf has experienced immense controversy over the introduction of new technologies that challenge the core principles of the sport. In some cases, a specific piece of equipment is replaced by one that requires less skill to perform the same

function while in other instances, a part of the equipment is altered slightly to create advantage for players using it.

The golf ball has been subject to controversy at multiple points in its history. A new golf ball introduced with a rubber core replaced the original “gutta percha” construction in the early 20th century. The design of the newer ball is conducive to achieving greater traveling distance, therefore requiring less strokes to complete a course. The players who had become skilled in the use of these newer balls noted this change in performance. The rubber core golf ball was accepted by governing bodies and in its essence is still used in the sport today. (Ringeut-Riot, Hahn, & James, 2014)

Later, the Polara golf ball was introduced to the game and quickly garnered interest for its optimized dimple pattern on its surface, which reduced the tendency of the ball to stray from the intended target line. Ultimately, the Polara golf ball was banned as the governing body determined it benefited lower skilled players more than those who were technically better at the game. (Dyer, 2015)

More recently, slight alterations to clubs have had much larger impacts on the sport than initially intended. The use of U shaped (square) grooves in a club head was introduced to the sport but was subject to complaints. The U shaped grooves gave golfers an advantage by creating a higher spin rate, which translated into better ball control. After backlash from PGA Tour professionals who were opposed to the use, the PGA Tour outlawed the use of U shaped grooves, feeling the design reduced the skill necessary to play the game. (Miah, 2007)

As demonstrated in the previous golf ball examples, having multiple governing bodies within the sport was not always as effective as it is today. Evidence of this is portrayed with the

introduction of the steel shafted golf club to America, circa 1922. In Europe, where the R&A determines the rules of golf, wooden shafted clubs were the only equipment permitted to be used in tournaments. At the time, the USGA accepted this new technology into the sport, but the original governing body located in Scotland, the R&A, did not accept it, creating an inconsistency in the rules among the two governing bodies. (Dyer, 2015)

The advancement of technology and the improvement of athletes is imminent as we progress as a society, but both factors are only exacerbating issues at hand. In the Distance Insights Report, the USGA and R&A offer a scope of how hitting distances have changed in the sport. For the purpose of examination, "elite" golfers are highly skilled amateurs and professionals and have the most information available. From 1900 to 1930, hitting distances among elite golfers increased substantially following the widespread adoption of the new rubber core ball. The new ball allowed elite players to drive the ball in the range of 220-260 yards, whereas with the old ball players were in the range of 160-200 yards. ("Distance Insights Report," n.d.) This is a significant change in the sport that occurred in a relatively short period of time and as a result of a significant change in equipment used.

Further, from 1930 to the mid 1990s, hitting distances of elite golfers continued to increase but at a much slower rate. During this time, the longest 20 golfers on the PGA Tour averaged 278 yards, where the PGA Tour average was 263 yards. ("Distance Insights Report," n.d.) This steady increase in distance was caused by smaller, incremental improvements in equipment, like dimple patterns on the golf ball and different flexibility of the clubs.

As the 21st century approached, the golf community was met with cutting edge innovations in club and ball design that again modernized the way that golf is played. Players hit the ball further than ever imagined as oversized titanium driver heads, spring-like effects, and

multi-layered balls were introduced to the sport. As the century turned and these innovations were refined to near perfection, golfers continued to perform at ground-breaking levels never seen before by the sport. From 2003 to 2019, the average drive of the 20 longest hitters on the PGA Tour and European Tour was 310 yards; a more than 100 yard increase from just less than a century prior. ("Distance Insights Report," n.d.)

As it relates to golf, there is quite a lot left to be done moving forward, but how this is handled may have consequences on the sport. Currently, the USGA and R&A are working to determine the most appropriate method to account for increased hitting distances in the sport. Overall in the sport, it seems there is an unnecessary degree of emphasis on distance, taking away from the other essential attributes critical to performance in the sport. Furthermore, performance is not the only aspect of golf, as it is still a "game" meant for recreation among the masses.

Today, golf is on the brink of controversy that it has never experienced in so much depth before. Players are hitting the ball at unfathomable lengths and courses are struggling to keep up with the advancement in performance. Further, the governing bodies of golf are again presented with the pressing issue; how do you preserve the sport in the face of technological innovation?

While technology has had a direct impact on hitting distances, and performance in general, in the sport of golf, technological advancements are targeting the "elite" golf players, who are the minority among the golf-playing community. The majority of golf players are not looking to break records, nor pursue a professional career, but rather enjoy golf as an engaging pastime.

Conclusion

In sports at large, new technology is released seemingly every day that in some form disrupts the traditions of that specific sport or the entire sporting landscape as a whole. Throughout the history of sport, technology innovation has played a vital role on the traditions, progress, and popularity of sport. The study of the relationship between technology and sport is a complex issue involving many issues, perspectives, and interests. If technology in sport is changed, it is typically easy to pinpoint the impact on the sport, but it is not always clearly or robustly defined whether this innovation is the best ethical outcome for the sport. Governing bodies in sports are tasked with understanding and managing technology so that it does not take away from the true value of the sport. Overall, technology development should enable people, regardless of skill level, to play the sport, rather than define who can play it.

Bibliography

"About the USGA." (n.d.). *USGA*, United States Golf Association.

www.usga.org/content/usga/home-page/about/usga-leadership-098d7fde.html.

Distance Insights Report. (n.d.). United States Golf Association and Royal & Ancient Golf Club of St. Andrew's.

https://www.usga.org/content/dam/usga/pdf/2020/distance-insights/SOC-FINAL.pdf

Dyer, B. (2015). "The Controversy of Sports Technology: a Systematic Review." *SpringerPlus*, Springer International Publishing. www.ncbi.nlm.nih.gov/pmc/articles/PMC4575312/#CR19.

Goodner, J., Gillmeister, H., Moran, F. (2020). "Sport: Golf." *Encyclopædia Britannica*, Encyclopædia Britannica, Inc.

www.britannica.com/sports/golf#ref222221.

Laird, N. (n.d.) "Golf Ball from Hairy to Haskell." *Scottish Golf History*, www.scottishgolfhistory.org/origin-of-golf-terms/golf-ball-feathery-gutty-haskell/

Miah, A. (2007). Rethinking enhancement in sport. Annals of the New York Academy of Sciences.

https://www.academia.edu/2253996/Rethinking_enhancement_in_sport

Ringuet-Riot, C., Hahn, A. & James, D. (2014). A structured approach for technology innovation in sport. Sports Technology

https://www.academia.edu/17290683/A_Structured_Approach_for_Technology_Innovation_in_Sport

"The Evolution of the Golf Club." (2018) *Professional Golfers Career College*.

golfcollege.edu/evolution-golf-club/.

Whaley, S., Richerson, J., Lindert, J. (n.d.). “About.” *The PGA of America*, Professional Golf Association.

www.pga.com/pga-of-america/about.