

CURB

Thesis Project

A Collection of Golf Clubs and Balls to be Optimized for the Urban Environment

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Table of Contents

Title...1

Table of Contents...2

Introduction

History	4
The Athlete	5
Jobs to be Done	5
Golden Circle	6
The Problem	7
Rules	8
The Environment	9
The Goal	10
Product Line	10

Market Research

Drivers	10
Irons/wedges	13
Putters	17
Golf Balls	19

Patent Research

Drivers	20
Irons	21
Putters	22
Golf Balls	22

Trends

Color	23
Graphics	24
Logos & Branding	25

Athlete Science

Physiology	25
Biomechanics	27
Psychology	31
Research Methods	31
Results	32

SWOT Analysis

Drivers	32
Irons	36
Putters	37
Balls	39
Testing Plans	
Durability	40
Ball Flight/User Experience	41
Impact	41
The Design Process	42
Works Cited	57

Introduction

History

The game of golf has a rich history that dates back to the 1400's as one of the earliest organized sports in the world. In its early days the game was played with the natural landscape of the eastern coast of Scotland which consisted of windy conditions, massive sand dunes, and grass large enough to hide the best golfers ball. Players fashioned their own clubs out of bent wood and balls were made of feathers and cow hide (Johnson, 2020). The game quickly became more organized and attracted the noblemen and high society of the United Kingdom. During the 18th century some of the game began to steer away from using the surrounding natural landscape and the first developed courses began to take shape such as the infamous Old Course at St. Andrews (History of the Old Course, n.d). With these courses and the United Kingdoms' worldwide influence the game began to explode not only in its' home nation but across the globe. However, even with this expansion the rules and traditions both written and not of how the game was played, how to act while playing it, and most importantly who played it remained firm. The game held true to its' ideals that it was strictly a gentlemen's game played by wealthy and powerful men. This history bears an immense amount of tradition that has passed the test of time and remains a pertinent part of the game even today but has slowly begun to evolve.

As the game continued to grow with material and manufacturing innovations clubs prices were brought down allowing for more people to be able to afford the fees and equipment needed to play. However, even with these advancements the prices to play remained high for most people and the wealthy continued to hold a strong grasp on the control of the game (White, 2002). The financial barrier to play the sport kept the game from growing and prevented many from learning the game even if they wanted to.

To even further blockade the entry into the sport countries like Germany implemented a golf license, called a "Platzreife" to play a round of golf at any club, private or public. It requires the athlete to go through a five day course costing around \$300 which includes multiple tests culminating in a full round of golf where they must shoot below 108 which can be extremely difficult for an amateur golfer (International PGA, 2022). This drastically limits the amount of the people that want to or even could play golf and exemplifies how difficult it can be to learn and enter into the game given the social, financial, and governmental barriers put in place.

These sort of restrictions and stereotypes has led to drastic changes in the game in order to allow for a broader reach to the public, most notably with the sport of Urban Golf. As Germans that did not want to go through the rigorous process of obtaining a license and spending excessive amounts of money to keep playing they took to the streets in the early 1990's and made the city their course and thus urban golf was born (Greze, 2015). Unlike traditional golf which is played at expensive clubs and courses on a large manicured parcel of land, urban golf is free to play and goes back to the roots of golf by utilizing the natural urban environment that society lives in today just like the founders of golf in Scotland utilized their given surroundings. Much like traditional golf the goal of urban golf is simple, hit your target in as few shots as possible. The twist with this sport is that there is no designated course and there is no hole in the ground. A course is drawn out on before each round and played among either streets, parks, college

campuses, etc. and rather than hitting the ball into a hole the athletes use a bench, street sign, post, etc. as identified beforehand with the end goal being to simply make contact with the ball and that object to finish the hole. Aligned with its original goal, the game is free to play as it is in public spaces and just a few clubs, oftentimes bought second hand, are used in tandem with a tennis ball or foam ball. Oftentimes this style is more focused on fun and a community feel stepping away from the strict traditional style of play seen in normal golf provides an easy access starting point for athletes that wish to begin playing the game by removing all the barriers that traditional golf may have that prevent people from learning. This has led to an expansion of the game and reaching a much larger population.

To date the game has continued to grow and now has competitions across the globe such as the European Urban Golf Cup as well as the World Urban Golf Cup and played in many cities across the globe such as Paris which recently opened the first permanent and official urban golf course in the world in June of 2022 (Paris Street Golf, 2022). France as a country as well has likely the most urban golfers in the world with an estimated 20,000 (Pruned, 2008). This shows how much the sport could grow worldwide as it already has in France and is evidenced even more so when taken into account the fact that out of 37.5 million golfers in America in 2022 around 33% of them were entirely “Off-Course” golfers meaning they went to the driving range or practice facilities but did not play a full round of golf. This proves that there is a huge market for people wanting to get involved in the sport but due to the barriers in place such as finances they are unable to. However, if we are able to help grow the sport of urban golf then those 33% (12.4 million) could have a free introduction into the sport.

The Athlete

The people that this sport attracts by its nature is not the stereotypical golfer but in contrast is a wide array of people seeking a cheap, fun, competitive, and unique experience. As opposed to traditional golf the score is oftentimes not the main focus but rather the good times and community feel. This is best exemplified by the Portland Urban Golf group that starts each round at a brewery to get sufficiently relaxed and good times rolling with some beer before “tee time” (Rob, 2022).

In accordance with this sort of atmosphere the typical athlete in urban golf and the one that will be the focus for this thesis project will be the younger generation around the age of 21-35 that is a competitive yet relaxed and easy going individual looking to get into golf with urban golf being an easy to start yet competitive and fun option. These urban golfers are not professionals or at the elite level but rather a competitive person looking for that challenge in their life without the stress of a large commitment both financially and socially.

Jobs to be Done

Although the USGA (United States Golf Association) allows up to fourteen clubs in a sanctioned traditional golf match (Topic-Clubs, 2019) these clubs can typically be broken up into only three categories that reflect the usual jobs to be done. Those being a driver or wood to achieve maximum distance, wedges/irons to play the medium and short distances, and the putter to roll the ball effectively into the hole. Although the terrain may be different these same general jobs to be done are very similar in urban golf. The terrain in which traditional and urban golf is played is drastically different and must be taken into account when determining specifics on how to play. Such as the fact that many shots in urban golf are played off very hard surfaces like concrete

versus traditional golf where you would usually take a drop and a subsequent stroke penalty to avoid such a scenario. The current clubs used in urban golf are typically cheap second hand clubs and usually athletes only use one club to perform all shot types which creates a large performance gap when being competitive. These clubs are typically found at places like yard sales or thrift stores to keep in-line with the idea of saving money but also to be able to use a club that the user will not mind being beat up by the hard surfaces encountered in urban golf. The clubs that are designed for golf now especially the older ones found at these yard sales are not made to withstand these repeated impacts on hard surfaces which is a major job to be done which has no current solution. The other essential piece of equipment in both traditional and urban golf is the ball which displays another difference in the two versions of golf. Tennis balls are the preferred option in the urban environment to avoid damage to the property but in turn suffers in performance. The typical tennis ball that is used in urban golf is optimized to be hit by a racket across a court, a relatively short distance as compared to a golf hole, and is even bigger than the club face that is meant to launch it diminishing its performance even further. These inefficiencies and lack of design of the essential equipment in this urban golf world are the reasons and inspiration for this thesis and lead to the problems that will be solved for over the course of this project.

Golden Circle

Using the golden circle theory explained by Simon Sinek the author declares their own self-interests in hopes of growing the game of urban golf by improving the ability of athletes to play the game with equipment that uses innovative materials and design that will be specific to enhance play in an urban environment.(TED x Puget Sound, 2010).

This goal will be accomplished by using the writers inspiration and strengths identified through the Clifton Strengths Finder and listed below (Gallup, 2022).

1. Achiever
2. Analytical
3. Learner
4. Developer
5. Individualization

These strengths, specifically analytical, developer, and individualization will be utilized extensively to make this project successful. Performance is a key aspect of the goal of this project and the analytical perspective is ideal to test and analyze every detail of the final product to ensure it achieves a high level of performance. The developer strength is ideal to organize every part of this project and make sure deadlines are met as well as have each aspect comes together into a quality final product. Individualization is perfect to connect to the consumer as the sport is niche and the athletes that play it are a relatively small population that in nature are separating themselves from tradition. In order to connect with them this individualization strength will be ideal.

It is important to not the author's own motivation as they have intentions of working within the golfing industry post-graduation. This therefore aligns well with this project in showing the ability to work through a golf club and ball design from research all the way to manufacturing. In alignment with this goal, mentors within the industry have been contacted and agreed to help oversee this project from a professional perspective. Jeff Brunski (VP of Research and Development, Cleveland Golf) has agreed upon meeting 1-2 times per month throughout the duration of this project (**Figure 1**) to give insight on how the design and testing process works

within his own company and offer his own advice and direction of this project. As well, Doug Roberts (Senior Design Director, Cobra Puma Golf) has agreed to help answer any questions and offer advise through this project (**Figure 2**) but a more defined schedule is yet to be agreed upon in terms of meeting throughout. As a senior director he has expertise in overseeing virtually all aspects of the design process from research to production and therefore will be invaluable to help this project develop through each stage and reach the final goal of creating a quality final product.

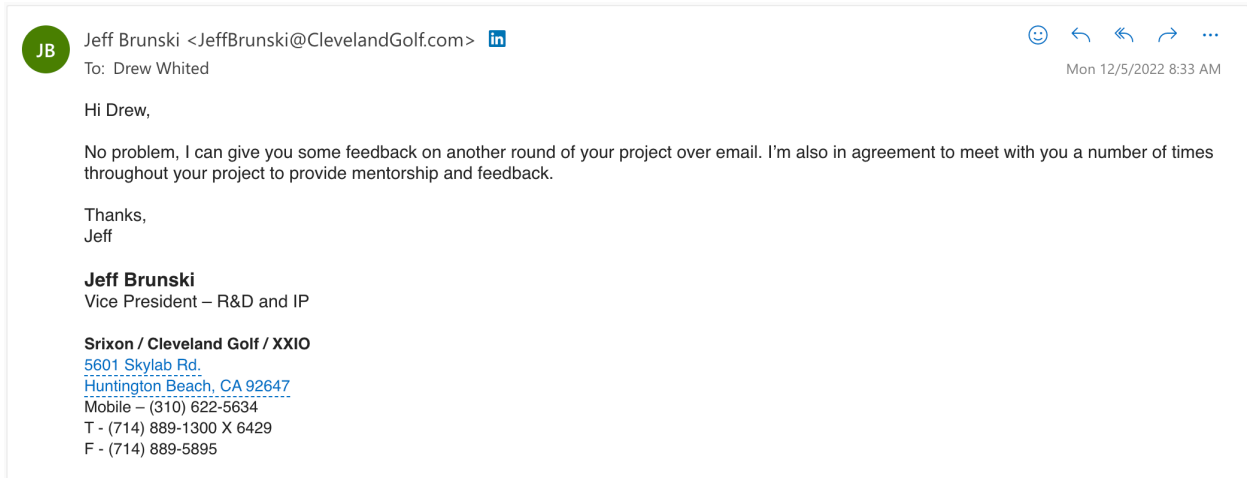


Figure 1

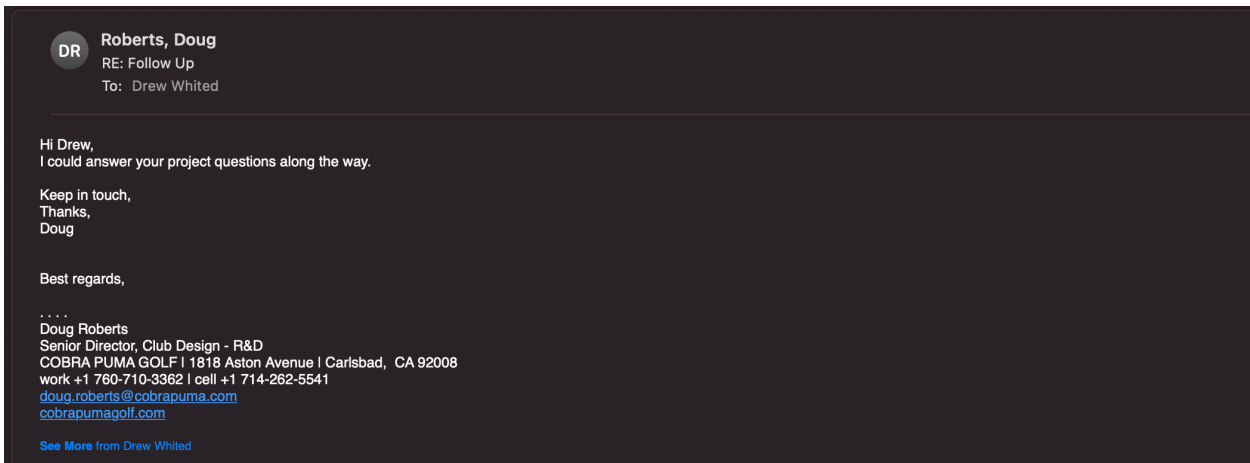


Figure 2

The Problem

Keeping in mind the jobs to be done in the urban golf setting the problem areas in the equipment used were identified and are listed as the following.

1. The clubs used currently lack the resiliency and abrasion protection that is needed to hit the ball repeatedly off hard surfaces that are prevalent in the urban golf environment.
2. The clubs used currently are simply old versions of current golf clubs and lack the innovations that have advanced performance in golf and coincidentally lack performance in urban golf as well.

3. The balls used currently are designed entirely for a different sport and therefore offer no specific advantages to the sport of urban golf.
4. The balls used currently do not fit the right standards or shape to optimize flight time, distance, interface with the club, weight, and aerodynamics.

All of these problems will be solved in hopes of growing the game of urban golf and golf as a whole by improving the ability of athletes to play with equipment that will use innovative materials and be specifically designed for athletes to use in urban environments. However, before a goal is set for this project several more parameters must be set as guides in the research and design process such as the rules that guide the sport.

Rules

The major problems being laid out previously will be the main objective to solve but to understand further how to make innovative equipment to expand the sport the rules must be understood. As traditional golf is one of the largest sports in the world with an estimated 66 million people playing as of 2021 (Golf Monthly, 2021) the games rules have been remarkably standardized. This helps so that no matter where in the world an individual plays the game, especially in major competition, it can be understood and played the same. Since urban golf was derived from traditional golf many of the rules that apply to traditional golf as well apply to urban golf but with subtle variations depending on where you play. Some differences apply in the equipment used, specifically the tee and use of turf. In some cities people play their tee shot off turf, bottle caps, rubber tees, etc. and others do not and even in other cities athletes are allowed to use a turf mat to hit all shots on. For this project, in line with the idea of using the authentic surrounding environment it will be assumed that athletes may use some form of tee for their first shot of each hole but no matts will be used. Most importantly, the primary rule is to reach the hole in as few shots as possible similar to traditional golf. Where the rules skew slightly is with club choice and hazards. As in traditional golf where there is the limit on clubs urban golf oftentimes establishes limits on the amount of clubs but with no official governing body for the sport this may vary depending on where you play. The main rule to keep a level playing field is simply to have an agreed upon amount of clubs before the match starts so everybody is offered a fair game (Priest, 2011). Hazards as well vary slightly from traditional golf since there is no set course. The courses and holes are laid out differently before the start of each match with often no hazards established. One example of a course layout is provided below in **Figure 3** with the hole names and par standards corresponding in **Figure 4** and is based upon the “South Waterfront” course based in Portland, OR.



Figure 3

1	TRASH CAN	PAR 4
2	55 GALLON DRUM	PAR 4
3	PERMIT REQUIRED	PAR 3
4	AROUND THE CORNER	PAR 4
5	ABANDONED CAR	PAR 4
6	TROLLEY TIME	PAR 4
7	UNDERGROUND PARKING	PAR 4
8	LOW CEILING	PAR 3
9	LET THERE BE LIGHT	PAR 4
10	OTHER SIDE OF TRACKS	PAR 3
11	U TURN	PAR 3
12	GOOOOOOAL!	PAR 4
13	UPS DELIVERY	PAR 4
14	RENT A CONTAINER	PAR 5
15	FIX THAT LIGHT	PAR 3
16	UP AND OVER	PAR 4
17	BETWEEN THE BUILDINGS	PAR 5
18	PICNIC BY THE RIVER	PAR 5

1	2	3	4	5	6	7	8	9	IN
10	11	12	13	14	15	16	17	18	OUT

Figure 4

This shows the lack of identified hazards but as a general rule of thumb the game is meant to be played away from residential areas and if a ball is hit upon a property in which it cannot be retrieved a one stroke penalty is assessed (Priest, 2011). These rules must be accounted for when identifying the amount and types of equipment to be designed for but the conditions in which they will be used must also be considered.

The Environment

The courses and their conditions must be addressed to fully define what the goal of this project and equipment to be designed must be. Due to the fact that generally people play urban golf by the same set of rules as traditional golf worldwide the target market will be focused internationally. That focus along with the worldwide span of athletes makes defining a set climate for this project impossible. Rather, it will be focused on working in all environments that are encountered in the sport whether that be night/day or rain/shine. The most notable condition to be considered especially for a new golf ball is the extreme climates such as rain which can and does severely affect the performance of the balls currently used. The clubs on the other hand oftentimes are not affected at all by weather conditions but the surfaces on which it is hit off matters greatly. There is a vast number of different surfaces seen in an urban environment such as grass, sand, metal grates, drains, bricks, and most of all concrete/asphalt. These surfaces must be accounted for when looking at designing new equipment as to effectively hit off but also to create something that will be durable enough to do so repeatedly without damaging the club. With all these factors and the previous rules and problems defined a specific goal for this project is ready to be defined and worked upon.

The Goal

With the problems identified the goal of this project was formulated and stated as the following.

How can we create a unique set of clubs and corresponding ball to help urban golfers differentiate themselves and to be played safely in urban environments while withstanding the impact against pavement?

Product Line

As urban golf has a major theme of saving money and having a relaxed minimalist mentality the club set will aim to adhere to those ideals by consisting of only the essential clubs that will be needed to accomplish the jobs to be done in a competitive environment. The set will consist of a three club system. First, a club to be optimized for distance to be used for the golfer to generally use as their first club of each hole to gain maximum distance. Second, an iron to be optimized for the approach shots that will be made for medium range while maintaining accuracy and control to get as close to the “hole” as possible. Lastly, a club to be used for the short range putts that will be optimized for maximum accuracy and precision to finish the hole in a minimal amount of strokes while keeping in mind the style of holes that are present in an urban golf environment. Coinciding with this club set, a golf ball must be designed with the environment it is used in and its performance as the primary focus. The ball must fly in a similar and effective manner as a traditional golf ball but made to prevent damage to the windows, fences, cars, etc. that is abundant within cities.

Market Research

Before design of this collection begins it is pertinent to study and analyze how the current state of the art clubs and balls as to how they are manufactured and of what materials they are made. This research will provide a tentative roadmap for designs of the new collection to follow so as to know what characteristics of the current products should remain and what can be improved upon to optimize the products for the urban environment. Since the collection will consist of a driver, iron, wedge/putter, and a ball then the processes to create these products will be analyzed individually.

Drivers

Drivers are arguably the most complex club in a typical golfer's bag that has countless hours of design, engineering, and testing done to create the perfect club for the athlete. The driver must be aerodynamic, offer great energy transfer, and launch the ball as far as possible. Everything from the “look, sound, and feel” (THP Golf TV, 2017) must be perfected to create a quality club that will not only perform well but make the athlete confident in their game. Most companies have small variations in their design and engineering of the club but a typical breakdown of the parts included are shown below in **Figure 5**.



Figure 5

The main body of the club is typically made of “titanium as the main source material” (Honest Golfers, 2021) which offers a great strength to weight ratio. This is where extreme engineering and testing is done to alter the weight, interior ribs, and curves by fractions of millimeters to achieve the perfect looking, feeling, and even sounding club. The club face which is responsible for the interface as well is also made of titanium. The crown and sole are then oftentimes made of carbon fiber which “enables them to save weight and move it elsewhere” (Hopley, 2016). This saved weight and the addition of weight inserts whose location can be adjusted allows for more dynamic designs. This redistribution of weight moves the center of mass (COM) therefore altering the moment of inertia (MOI) which can be increased and utilized in the case of making a club that is “super forgiving...by getting the weight low and back” (Hopley, 2016) or in the opposite case make a responsive driver by moving the weight high and forward.

These methods and materials are always evolving however and to create the next great equipment these new innovations should also be addressed and focused as a benchmark of what to achieve. Recently Titleist released their TSR2 Driver that claims create maximum speed and distance. At a price of \$599 this new design most notably incorporates a variable face thickness design which along with its “Improved aerodynamics and aerospace grade titanium” (Titleist, 2022) are supposed to create the ultimate high performance driver which can be seen in **Figure 6**.



Figure 6

Another example of driver innovation and arguably the biggest innovation in this space in recent years was the Taylormade Stealth Driver. At a price of \$579 the stealth is the first club to use carbon fiber as the face plate as compared to the traditional titanium. According to Taylormade their new carbon face is “comprised of 60 layers of carbon sheets strategically arranged for better energy transfer and faster ball speeds across a large area of the face” (Taylormade, 2022) and is displayed in **Figure 7**.



Figure 7

Both of the above drivers are excellent examples of innovative technology pushing innovation for drivers and are great examples for this project but an analysis of common clubs for urban golf must also be done. People often use older/cheaper clubs for urban golf for their ability to be scraped up and replaced relatively inexpensively and are easily found at websites like Craigslist or Ebay along with in person at thrift stores or businesses like Goodwill. A quick search on Craigslist offers several good examples of what could be an effective club in the urban environment, one of which is shown below in **Figure 8**.



Figure 8

This club was listed as \$40 and is a Taylormade V Steel 7 Wood. This club would work well against the hard surfaces in the city limiting the effects of abrasion compared to the composite materials that most new drivers and fairway woods use at a much smaller price point.

Irons/Wedges

Irons and wedges in contrast to drivers are more focused on the ideal distance and spin control not so much the maximum distance and their design as well reflects that focus. An athlete must be able to hit the ball within feet of a desired distance and either increase or decrease spin when needed and so these irons need to allow them those capabilities. With irons and wedges there are two main modes of manufacturing them, those being either a casting process or a forging process.

The casting process is the most common manufacturing method because its simplicity as well as the ability it allows to create “very intricate shapes which allows for variations in weight distribution” (Golf Club Technology, 2022). The majority of casted clubs are made from stainless steel however, some of the cheaper clubs or the ones people would find while thrifting getting ready for an urban golf match use Zinc to cast their clubs. This is not an ideal material as it is substantially lighter and has a noticeable “softness, which means they will ding and get marked up easily” (Golf Club Technology, 2022). As shown in **Figure 9** the casting process uses a mold which through several steps in combination with the molten metal creates the desired club.



Figure 9

After the mold is removed and club head is etched with any extra design details or markings it is polished and then welded to the hosel which will then be where the shaft is inserted and the final club will be ready for play.

The forging process in contrast to casting typically uses carbon steel which is then often coated with chromium and nickel to prevent rusting (Golf Club Technology, 2022). This process begins with a cylindrical piece of metal shown in **Figure 10** which is then heated, stretched and bent as shown in **Figure 11** to give the approximate angles required for that club. The first impression press is then applied with a forging hammer to give the club its first recognizable shape which can be seen in **Figure 12**. After using a dye cut and another impression forging round the club finally has its final shape and details such as its grooves shown in **Figure 13**. Grinding, polishing and painting finally creates the final product in **Figure 14** (Mizuno Golf, 2016).

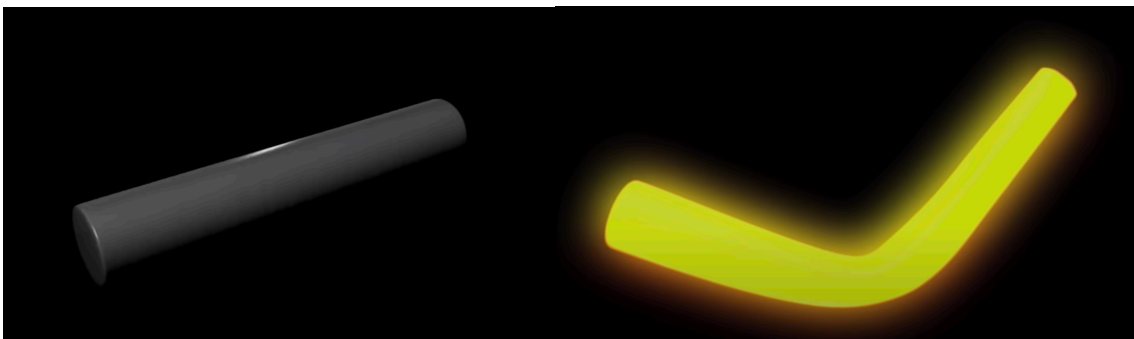


Figure 10

Figure 11

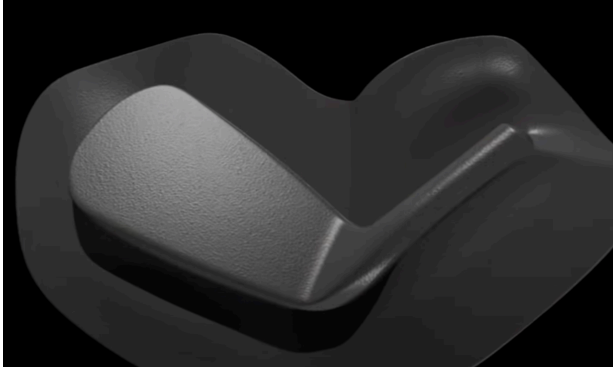


Figure 12



Figure 13



Figure 14

This process as compared to casting requires more steps and complexity as well as higher grade materials which results in higher prices but also a better quality. This process by nature creates a more malleable club which allows for a softer feel when striking the ball, which according to better players, “lets them control...the ball better” (Golf Club Technology, 2022). This does mean however that the lie (angle from the ground to the centerline of the shaft) and the loft (angle from the ground to the club face) are altered more easily and is the reason that pros have these measurements adjusted constantly while on tour.

With both of these methods however there are also two distinct types of irons that should be considered that are classified as blades and cavity backs. Blades are what is seen most commonly at the professional level. An example of a Taylormade P-770 blade iron is shown below in **Figure 15**.



Figure 15

This style features a thin and sleek look but with a much smaller sweet spot for contacting the ball. When the ball is struck appropriately the feeling is impressive and the performance is outstanding but mishits are quite noticeable and much more common. This is the reason most amateurs are advised not to start with blades and go with a cavity back iron that will work well with their inconsistent ball striking (Olizarowicz, 2022).

The cavity is the opposite end of the spectrum from the blade and offers forgiveness and smooth feel and thus is oftentimes used by people progressing in the game. The Callaway Rogue ST is shown as an example of a cavity back below in **Figure 16**.



Figure 16

Cavity backs as the name suggests has an opening in the back and pushes most of the weight to the perimeter of the club. This redistribution of weight increases the MOI creating a more stable and forgiving club. This along with its more smooth silhouette decreases amount of times the club will dig into the ground on mishits. The performance and feel of a pure strike on the ball may be diminished but for the amateur golfers the features in a cavity style lend themselves perfectly to that population (Olizarowicz, 2022).

Similarly to drivers innovations continue to evolve with irons whether that be paint finishes to reduce glare, improved groove designs to increase spin, and redistribution of weight and foam inserts as shown in **Figure 17** to offer better striking and continue to change the game. These advancements are important to study as possible innovations that would help or not and to incorporate into a club that would be optimized for this urban environment.



Figure 17

Putters

The final of the three clubs to be considered in this urban golf project will be the putter. The manufacturing methods and materials are very similar in these clubs as to irons and drivers but varies drastically in looks. Putter design unlike irons and drivers are not meant for speed but rather putters need to be extremely stable and smooth in their stroke. An example of a Taylormade Patina putter is shown below in **Figure 18** as a good reference to some of the possible innovations and features that could be incorporated into an urban golf putter as well.



Figure 18

As with irons, putters are manufactured using casting or forging processes and with similar materials as well, the most common being steel but also use brass, aluminum, titanium and others on occasion. Weights are available in many putters in the current market that are meant to be able to be adjusted to better fit the golfers specific individual stroke and make it as smooth and straight as possible. Composites are as well used in some putter heads as the impact surface to give it a nice sounds and energy transfer through contact with the ball. However, these current designs are made to roll the ball straight and flat with consideration of the greens they are meant

to be played on but not designed for the unique and interesting holes seen in urban golf. Since the streets that are played on in urban golf are not flat like traditional putting greens and some holes are even elevated off the ground a flat club face may not be an ideal design. Analyzing another club such as the Sitaline Putter & Chipper Combo pictured in **Figure 19** will be beneficial when considering a putter design for urban golf.



Figure 19

This club is unique as the club face loft has a loft angle higher than a putter but lower than a typical wedge which allows for either a chip or putt depending on how hard you hit the ball. Another club similar to the Sitaline club is the Yuma Chipper (**Figure 20**) which can serve as a good benchmark and possible design inspiration for the future solution.



Figure 20

The Yuma Chipper is sold for \$199 which is rather cheap compared to many of the state of the art putters offered on the market but still a large amount of money for an urban golfer that usually searches for clubs out of thrift store bins for just several dollars. However, this club does offer some key performance aspects that could be useful in the urban environment. The large sole and clubface makes it perform somewhat to a hybrid and limits the chance of chunking short

chip shots. This works well for hitting off surfaces like concrete where minimal contact with the ground is required to preserve the club. As well, the low loft of 37° on this club allows the ball to be chipped slightly in the air but not substantially which results in the ball rolling out similar to a putt. This is perfect for urban golf where “putts” are oftentimes required to be lofted in the air slightly but also roll out smooth like a putt in other circumstances.

Golf Balls

The last piece of equipment in the proposed collection is the golf ball. While playing in such a unique environment as a city this ball will have to possess capabilities that no product currently offers. The ball must fly well and in a similar fashion to a regulation golf ball but with consideration to the size of the holes in an urban golf match and possibly even more importantly it must be able to withstand impact with objects such as windows and cars that are prevalent in a city without damage to either the ball or object. Currently, the balls used are either tennis balls (**Figure 21**) or in most circumstances, such as organized competitions like the European Urban Golf Cup, foam balls such as the Almost Golf Ball (**Figure 22**) are used.



Figure 21

Figure 22

Both the tennis ball and Almost Golf Ball are relatively cheap, \$2.33/ball and \$3.33/ball respectively, and work to an extent in the urban golf environment but are not designed specifically for the sport and therefore lack in some performance areas. The tennis ball works extremely well minimizing damage but its rubber material and hollow design minimize the distance and energy transfer that is possible while hitting it with a golf club. It as well is affected even more so by the weather conditions especially rain. The felt exterior soaks in liquid and adds undesirable weight which greatly alters it’s performance and nearly makes it unplayable in extreme conditions. Similarly with the foam balls, they work great to minimize damage but as it was designed for indoor training purposes the weight of the ball is a third of a traditional golf ball and therefore typically flies only a third of the distance. It is made of synthetic cork material as well which does not offer exceptional durability. Both of these options work, but to optimize them for urban golf a comparison to the high end traditional golf balls is relevant and therefore a study on the best golf ball on the market in 2022 according to Golf Monthly, the Titleist Pro V1 (**Figure 23**) , must be completed.



Figure 23

This revolutionary ball was one of the first to introduce a multilayer core that helps optimize distance and spin control. Implementing multiple layers allows the ball to obtain key performance factors while not sacrificing others. According to their website Titleist claims that their inner 2.0 ZG core delivers speed and distance while the second layer adds speed and lowers long game spin while their new urethane elastomer cover increases short game spin and control. All these factors are good qualities to have in a traditional golf ball but the density of the materials used are still far too high to not cause damage. Looking at these designs and the current urban golf solutions a multilayer design incorporating aspects from all these balls could be used to create the optimal urban golf ball.

Patent Research

The previously mentioned innovations and products are great to learn from and use as benchmarks for this new collection but with most innovations patents tend to accompany them and therefore must be researched to keep this new urban golf collection safe from legal troubles. When it comes to golf this research can be tricky to maneuver as it is a very old sport with lots of different clubs and equipment used, evolved upon, and patented over the years. To filter through this mass of patents an emphasis was put on the innovations that were inadvertently helpful towards a urban golf setting and then filtered down again based simply on the types of clubs focused on for this project being the driver, iron, putter, and golf balls.

Drivers

Many drivers have patented technology in them that help launch the ball far but few address the impact with the ground and the durability that is needed especially for the surfaces seen in an urban environment. To find more information on this patents were looked at for hybrid clubs which are somewhat of a cross between irons and drivers. These types of clubs are important to look at as they have a very similar look and feel as typical drivers but usually are hit straight off the ground which is not often seen with drivers and so their design reflects this action. Below in **Figure 24** is a good example of this design and offers good information on how to create a club with similar performance capabilities as a driver but with consideration on how it will endure impact with the ground (Mickelsen, 2012).



(12) **United States Patent** (10) **Patent No.:** **US 8,272,974 B2**
Mickelson et al. (45) **Date of Patent:** **Sep. 25, 2012**

(54) **HYBRID GOLF CLUB HEAD** 5447309 A * 91995 Vincent
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 (21) **Appl. No.:** **12/814,744**
 (22) **Filed:** **Jun. 14, 2010**
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 (51) **Int. Cl.** (2006.01)
A6B 53/04
 (52) **U.S. Cl.** **473314, 473328, 473345, 473349**
 (58) **Field of Classification Search** **473314**
 See application file for complete search history.

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ABSTRACT
 (57) A hybrid type golf club head is disclosed herein. The hybrid golf club head preferably has an increased heel-toe camber to minimize drag through rough when a golfer swings the hybrid golf club. A sole of the hybrid golf club head is relieved to allow for the face angle to open without the leading edge lifting too high.

2 Claims, 5 Drawing Sheets

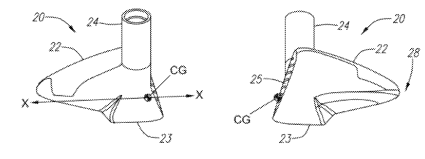


Figure 24
Patent No.: US 8,272,974

This patent is based upon the claims that it reduces drag during contact with the ground and offers new innovations that help golfers play more effectively out of the rough. An increased heel-toe camber accommodates those desires along with a forward COM as well as a more hollow design in the sole to allow for the face to open up more when desired meaning it can play well in either short or long grass and reduce the impact force with different variations of surfaces. This was designed with traditional golf in mind but is important to note as a main goal for this project is to design a solution for clubs being hindered by having a high impact force with the hard grounds in urban golf. Therefore, learning from this current solution is important as well as to be aware that there is a tentative solution that must not be copied while doing so.

Irons

Further looking into solutions for minimizing the damage and impact force with these hard surfaces patents were looked at for how the ground-club impact could have a decreased effect on the clubs motion and therefore the ball-club impact. Multiple clubs address this problem however there is one patent that offers innovations in increasing the MOI in the club which helps the club remain stable during the ground-club impact. The MOI is the resistance to an object rotating around a specified axis and in the cited patent the invention aims to increase the MOI along the heel-toe axis of the clubface therefore reducing movement of the club during ground-club impact. This is very important to note and make sure not to infringe upon this intellectual

property since hitting off hard surfaces has a huge effect on how the club will rotate during contact and the MOI will have to be adjusted largely to accommodate for this (Wahl, 2001).

Putters

In the case of putters the abnormal combination of launching the ball in the air and also being able to effectively roll it as needed in urban golf has not seen many patents that pertain to these tasks. However there is one particular patent pertaining to this task and has some drawings from their patent shown in **Figure 25** (Pollman, 2007).

U.S. Patent Feb. 13, 2007 Sheet 8 of 10 US 7,175,537 B2

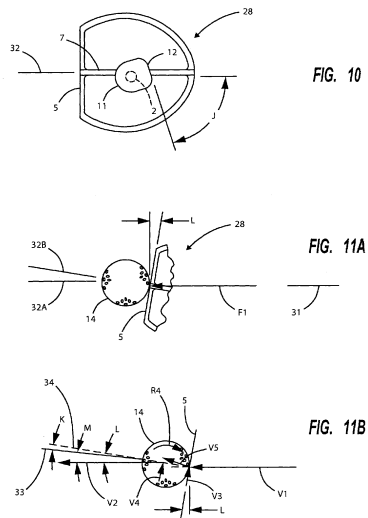


Figure 25
Patent No.: US 7,175,537

In this invention a slight lift angle was added to the clubface to increase the topspin of the ball but unlike what will be likely needed for this project it does not lift the ball fully off the ground. Topspin and good rolling mechanics are very prevalent in this invention and will be great to reference and improve upon to simulate those mechanics and allow the golfer to as well lift the ball off the ground.

Golf Ball

In the realm of the ball that is used there are countless patents to be analyzed and must be learned from and kept in mind during the design of this collection. One of the more relevant patents for a golf ball that could be learned from to translate to urban golf is one that has been approved and was filed by the Acushnet Company (**Figure 26**).

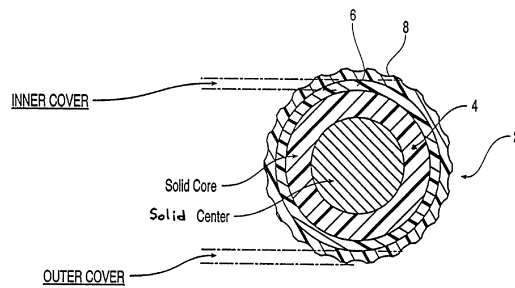


FIG. 1

U.S. Patent

Feb. 7, 2012

US 8,109,843 B2

Figure 26
Patent .: US 8,109,843

This company is the parent company of Titleist which produces one the renowned golf ball on the market as previously mentioned, the Pro V1. This patent is for the multilayer ball that is the same design as the Pro V1 ball. It is characterized by four distinct layers all of different densities which gives the ball performance characteristics in a wider variety of shots rather than just the performance qualities that only a single density could offer. An example of this would be while taking long iron shots where typically you want the spin to be low so you want a softer ball that will decrease spin when hit hard which this patent enables the ball to do so. In comparison it can also offer itself in the short game when the impact force is much less and acts more as a firm ball which can create lots of spin which is desirable when approaching the green. This multi-faceted type of golf ball could be very advantageous to an urban environment where you want distance and good aerodynamics of a harder ball but with minimized damage to the surroundings that a soft ball is capable of (Hebert, 2012).

The types of material and how they are used in a golf ball is important but with a ball that is hit at such high speeds and large distances the aerodynamics play a huge role and is why there are such a large amount of patents as it pertains to the dimple patterns on these balls. One patent filed by Callaway Golf Company is a great example of how in depth the engineering and design of these dimples are and the effect they can have on the flight of the ball. This patent has sets of dimples which varying size across the golf ball rather than strict uniformity which “reduces high speed drag on a golf ball while increasing its low speed lift thereby providing a golf ball that travels greater distances” (Ogg, 2004). Once again this patent is a great display of how to utilize dimple patterns to create a ball that will travel farther and is important to note as to not replicate but instead innovate upon this idea.

Trends

Color

The colors and clothing of traditional golf in line with its tradition have for the most part been relatively strict and dull with mostly uptight looks consisting of slacks and golf shoes resembling dress shoes (Glenmuir, 2022). Even more so, with the clubs that are made there is little to no color added with companies relying on simple blacks, whites, and the natural metal color which leaves the clubs looking very strict and serious as is the stereotypical golf vibe. With this new group of urban golfers they are looking to step away from these traditional colors and want something to help them stand out and so colors with this in mind combined with the somewhat retro/thrifted style of Portland the following colors will be incorporated into the product.

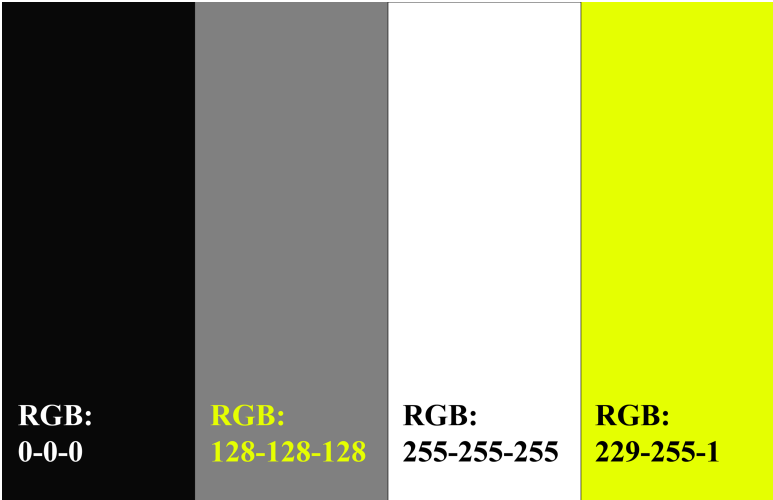


Figure 27

Graphics

Graphics as well have been very limited in the traditional style of golf and again reflect the stereotypical “country club” vibe. Especially on golf clubs graphics are often relatively plain or non-existent consisting of sharp edges, straight lines, and black & white lettering with limited creative design which can be shown in some clubs that are shown in **Figure 28**.



Figure 28

However, in-line with the sport they play, urban golfers are looking for something different, new, and fun. They do not want their clubs to be looking just like the same clubs that have been made

before as they are playing a game that is entirely based on being different and fun and the graphics should reflect that.

Branding & Logos

When it comes to the logos of the major golf club makers and the branding they implement they as well conform with this traditional golf aesthetic that many urban golfers are trying to escape. Many of the logos used today in the industry are very standard black and white with simple lettering and few graphics or variations used. As well, when it comes to putting these logos onto their products mostly all use very small and simple branding as shown in **Figure 30**.



Figure 30

As seen above the logos are very limited in location, frequency, and size. To remain with the urban golf counter-culture a new logo system and branding strategy should be used to step away from these traditional methods. Good examples of how to do this are again shown in the new golfing apparel industry where companies have begun to add more exotic logos and branding everywhere and can be seen in some logos shown below in **Figure 31**.



Figure 31

Athlete Science

Physiology

Golf has long been perceived as a sport with simple movements able to be completed and played by people with little to no athletic training. By its nature the sport does not involve extreme movements such as a dunk in basketball, a high level of cardio as in a marathon, or even a large amount of strength as seen in football. In the games earlier years it was not uncommon to see

even professional golfers with noticeable beer bellies and brag about not using physical training to improve their game. An evident example of this is Jon Daly, a PGA Championship winner and Rookie of the Year Award winner in the same year of 1991 while simultaneously being renowned for his lack in training and unconventional diet (Mahoney). Talking about his typical warmup routine he is even quoted as saying he “smokes 4 or 5 cigarettes drinks 3 diet cokes and goes to the first tee” (Prabhakaran, 2022). Daly along with others enhanced the image of the sport being one that does not require any level of fitness or training. This soon began to shift however, largely influenced by one of the greatest golfers of all time, Tiger Woods and led to a change in the way athletes approached the game. During his rise in the late 90’s and early 2000’s Tiger’s fame began to rise not just due to his immense success but also his intense workout routine that the sport had never seen before and helped set him apart from the competition (McCormick, 2021). With this new influence and an increase in physiological research surrounding the sport, athletes began to realize the large impact fitness and health could have on the game.

In a study conducted in 2009 by the University of Toronto, a correlation between several different physiological factors and success on the golf course was conducted to further explore the effects of fitness and golf. Correlations were made between balance, flexibility, abdominal strength, peripheral muscle strength, and aerobic capacity and the effects they have both in a laboratory setting (ball speed and distance) as well as tournament conditions (average score, greens in regulation, putting measures, and putting accuracy). In both balance and flexibility testing significant correlations were seen with higher ball speeds at impact and carry distance after impact with drivers and irons. This can be assumed to be a result of the athlete being able to have a larger range of motion particularly in the backswing causing a greater impact from the stretch-shortening cycle that will be discussed further in the Biomechanics section. As well, the balance is assumed to help stabilize the athlete through the swing especially in approach shots where the ground is unstable.

Greater abdominal strength as well showed a correlation with better golf in terms of ball speed, carry distance, and putting distance after chip shots. Just like with many other sports and athletic movements the abdominal muscles are what connects the upper and lower portions of the body and therefore is what dictates so many of these movements. It is then assumed that the correlation is a result of the abdominal muscles creating the torque through the swing thus causing an increase in both ball speed and distance. In the short game it is often desirable to limit the amount of muscles and limbs moving as to increase precision and so it is assumed the abdominal muscles are the main muscle group in charge of holding the body stable to achieve this resulting in shorter putt distances after chip shots.

Peripheral muscle testing showed correlations between leg power, upper body strength, arm strength and distance as well as average score. It is no surprise that increased strength results in increased distance on both iron shots and drives but is important to note that in a sport like golf there can be a limit to this as a major factor in distance as noted above is flexibility. As strength and muscle increases flexibility often decreases which results in shorter distances so a balance must be found between these two variables to maximize distance (Park, 2020).

Lastly, aerobic capacity was tested against the both lab and tournament conditions and surprisingly showed correlations to success in the sport as well. At the elite level competitions typically do not allow the use of golf carts which means the athlete must travel the 7000+ yards of a course under their own power. However, even then they walk and are even allowed to have a caddie that carries the clubs for them. Under these conditions one would not assume that cardio would have an effect on the game but through this study that assumption was proven false. Athletes with higher VO₂ max scores were proven to have better chip shot efficacy as well as a better putting average. This is indeed an interesting finding but the study does suggest that athletes that train in other capacities to improve their game have a higher aerobic capacity as a result and so the better performance may be a result of general athleticism and not specifically aerobic capacity. This is simply a hypothesis however and further testing would have to be conducted to determine causation rather than correlation. In any capacity this study is important to acknowledge as it shows that the long assumed limited athletic ability required to golf may be false and shows the more athletic golfers typically will see greater results (Journal of Strength and Conditioning, 2009).

Biomechanics

The biomechanics of the golf swing unlike physiology has long been studied as a complex and precise science in golf as fractions of a millimeter can result in drastic changes in a ball flight. Starting from the tee shot the typical jobs to be done are one, to achieve the greatest distance possible and two, to hit the ball along the intended target line. While considering how to achieve maximum distance off the tee, or accurate distance for approach shots, the swing can be simplified into a relatively basic equation where the club should hit the ball with the ideal linear velocity (V_{club}) at impact. The swing created by a golfer however is not linear (**Figure 32**) and is a product of the clubs angular velocity (ω_{club}) and the distance the ball is from the center of rotation I (**Eqn. 1**).

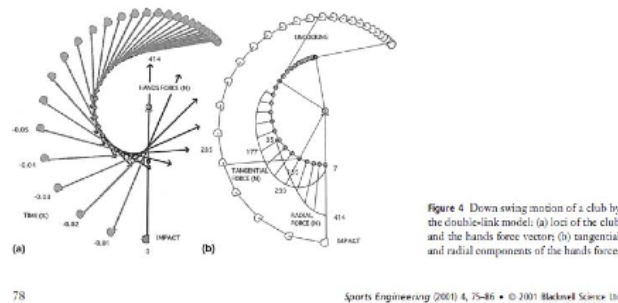


Figure 32

$$V_{club} = \omega_{club} r$$

Eqn. 1

Analyzing this equation it can be determined that to achieve desired velocity the athlete would like to have the perfect combination of radius and angular velocity. As for the angular velocity this is largely determined by the factors discussed in the Physiology section, most notably flexibility, balance, and strength. As the angular velocity can be defined as the displacement over

time (**Eqn. 2**) it becomes apparent that the larger backswing allows for a greater displacement as long as that displacement can be traveled in a short amount of time.

$$\omega_{club} = \frac{\partial \theta}{\partial t}$$

Eqn. 2

This is achieved through the stretch shorten cycle where the flexibility in the muscles essentially turns into a rubber band. The more you stretch the muscles the more potential energy they store which when released is converted to kinetic energy and results in a faster swing and increased ball speed at impact (Hume, 2012). This angular velocity is greatly important however, it is only half of the equation as the radius from the center of rotation affects the speed equally. Unlike the angular velocity though, the distance to the ball cannot be altered as much since it is a direct result of the golfer's genetics and the length of the club which also is only allowed to be 46 inches in competition (USGA, 2022). Therefore athletes must utilize their swing to optimize their distance to the ball by focusing on their shoulder, elbow, and wrist movements (**Figure 33**) (Rich H., 2009).

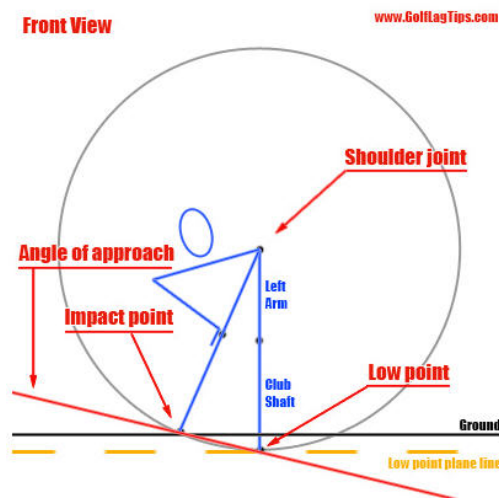


Figure 33

All of these joints along with using the legs must be utilized to both optimize the swing path and the club face at impact. Factors such as the angle of approach and impact point are greatly affected by the swing path and have the largest effect on the initial trajectory of the ball. As well, the club face at impact has a significant impact on the spin of the ball which determines how it will fly through the air and can be explained in **Figure 33**.

Ball Flight Laws

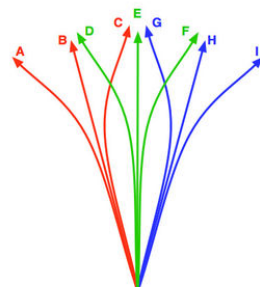
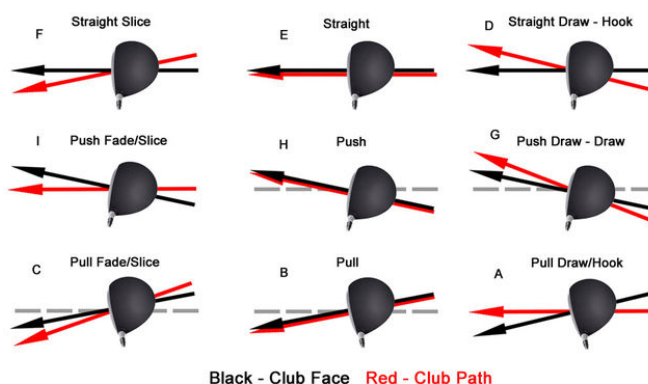


Figure 33

All of these factors are greatly important from the tee shot, to the approach shot, as well as chips. The best players are able to control all points of movement from their lower body to their upper body joints that connect them to the club such as their shoulders, elbows, wrists, and hands in order to optimize their shot to their desired distance and shot type. Although, the surfaces in urban golf are different that traditional golf these biomechanics and swing types are very similar and must be considered if the athlete is attempting to be successful in the urban environment as well as the traditional.

When it comes to putting however, the jobs to be done for the ball are drastically different and the biomechanics of the swing must as well undergo a drastic change to achieve ideal speed and control. Putting starts with reading the green to determine how the ball will roll and where your intended target line should be. Once a target line is determined the next task is to gauge the distance and get a comfortable stroke. Unlike the tee and approach shots there is no shot shape to achieve but rather all putts are desired to roll straight as can be and if the golfer read the green correctly the ground will guide the ball into the hole. To achieve this simple yet difficult task many different types of grip are used and shown in **Figure 35**.



Figure 35

Generally there is no one grip that works better than the other, rather golfers subjectively choose the grip that feels most comfortable for them. Once a grip is decided and comfortable with the golfer the kinematics and the stroke come into play. One study compared putting in mid to high handicap (amateur) golfers with low handicap (elite) golfers to determine some attributes that led to more effective putting. What was found is that generally the elite golfers had a shorter backswing with a more consistent velocity in their swing when compared to the amateurs that had larger backswings and were accelerating through the ball (Hume, 2012). This suggests that a shorter and more consistent swing paired with minimal movement in the upper body to limit error (**Figure 35**) will lead to more accurate and precise putts (Putting Stroke, 2022).



Figure 36

Although putting in a traditional golf environment requires the ball to stay on the ground, unlike urban golf where oftentimes the “hole” is off the ground, the biomechanics remain similar. No shot shaping is required and the flight or roll of the ball should be straight and extremely precise. In order to achieve this all the biomechanics from square shoulders and simple/short movements mentioned above should still be employed by the athlete.

Psychology

The biomechanics and physiology of golf are large factors in the athlete achieving success on the course or in the city, but as anybody who has played golf will know, golf is immensely effected by their mentality. A golf match often lasts four hours (as required by most courses), an endless variations of different shot types are used, and lots of time between shots all contribute to increased stress. As Jon Stabler says, “It is like the opposing coach calling time out before every shot so you have time to think about the importance of the result” (2020). To make things that much harder you have to master fourteen different clubs all that can be used in countless different ways with the threat of a single mistake adding onto the score. In most sports if you make a mistake there is often a teammate that can make up for that mistake or an opportunity later on in the game, such as scoring more points, to recover. On the contrary, all mistakes are on the individual athlete with no teammate to help and every mistake adds onto the score with no opportunity to erase that mistake later into the match. All these factors add up to a difficult and oftentimes stressful environment for the athlete and that is before considering the extra stress that some private clubs put on how you should dress and act while at their club. Winged Foot Golf Club in New York State for example has dress codes not just for the club but depending on who you are and what part of the club you are at. There is a dress code for the club grounds, golf attire for men, golf attire for women, golf attire for juniors, casual dining attire, and pool attire (WFGC, 2022). Realistically most clubs are nowhere near as strict about player conduct as this but for people trying to get into the sport these sort of policies can set stereotypes and seem daunting which leads to people not wanting to start the sport. This is a large reason why urban golf can cater to so many people’s needs that do not want that kind of stress in their game. Urban golf has no dress codes, no pace of play, and an overwhelming sense of community. All of these factors relieve the stress from the game and lead to a welcoming sport for athletes to begin to play or continue to play the game they love in a relaxed and stress free environment.

Research Methods

To further validate the research conducted and to further explore the world of urban golf a research plan was developed. With this project being based in Portland it is fortunate to have one of the country’s largest urban golf groups right here in the city. One of the organizers for the sport within Portland and a company that will be contacted for insight are the Munikids. This is an apparel brand that blends streetwear with golf apparel and as well happens to host a weekly urban golf meetup where they provide the clubs and balls and it is free to play, sticking with their manifesto to make golf “Inclusive Not Exclusive” (Munikids, 2023). To learn more about the sport and how it is played specifically within Portland an immersive research technique was used by interviewing the owners/employees of Munikids, mainly Drew Reinland, Max Reinland, and Eric Dahl and then following up by playing urban golf at their weekly meet-up to understand more about the sport and answer some of the following questions.

- 1) How many people are involved in the sport here in Portland?
- 2) Preference of tennis ball or foam ball?
- 3) What kind of tees do you use if any?
- 4) Do you use turf to hit off at any point?
- 5) Do you feel the clubs you use now could be improved to work in the urban environment?
- 6) How often do you replace your clubs due to damage?
- 7) Does the game vary depending on where you play?

- 8) Biggest problem with current clubs?
- 9) Biggest problem with current balls?

Results

Validation for this project was given as the Munikids recognized that equipment designed specifically for urban golf could be a useful tool to help grow and improve the game. They did stress that overall the people that play the game are there for fun and the community aspect. The score matters and competition is at the heart of the game but several comments pointed towards the fact that if equipment is designed for the sport it has to cater to these people and utilize a fun, weird, yet functional design to fit the type of athletes that participate. Further validation was provided in the product line selection as they commented that a three club system would work best to accomplish all shot types needed while remaining minimal as they did not want to carry many clubs with them through the streets. As well, it was observed and commented on that the foam balls that they used were not sufficient as a slight breeze would significantly affect every shot during the round and not a single athlete on any of the holes reached the hole in a single shot despite the holes being relatively short proving a better performing ball could be important for the game.

SWOT Analysis

To further understand the current market products a traditional analysis of these products strengths, weaknesses, opportunities, and threats (SWOT) was completed. Each product is viewed as its' individual parts and as a whole product focusing on the performance qualities of each.

Drivers

Looking at the tee shot on most urban golf holes the club choice has a large variation depending on the type of hole, weather, local rules, and ultimately the athletes own decision. Typically athletes do not use a traditional driver due to its hollow structure that is easily dented and will then lose its' performance benefits. However, if these drivers could be designed to maintain their distance optimization qualities with added strength to withstand any impacts against the ground then athletes may begin to use these type of clubs. A PING G 30 driver (**Figure 37**) was chosen to be analyzed as it conforms to the typical modern driver construction but is a good example of what an urban golfer may choose as a driver due to its' age and low cost on second hand golf websites.



Figure 37

This particular driver image was pulled from 2ndswing.com, a large retailer of second-hand clubs and is likely a place that urban golfers would shop as it has often low prices (\$100 for this club) on older well used clubs. The SWOT analysis of this club is shown below broken into its' individual components (**Table 1**).

	Strength	Weaknesses	Opportunities	Threats
Club Face	-Titanium face for strength -Large face compared to woods/irons (easier to hit) -More distance compared to woods/irons	-Larger face means more drag -Titanium is expensive	-Reduce size -Use different materials	
Club Body	-Aerodynamic fins for increased speed	-Larger volume than woods and irons (more drag) -Hollow structure	-Decrease volume -Utilize fins for speed	-Added weight -Could dent easily
Hosel	-Adjustable loft ($9^\circ \pm 1^\circ$)	-Weak connection to shaft compared to steel	-Change adjustment design	-Breaking on impact
Shaft	-Graphite shaft for speed/flexibility	-Weak compared to steel	-Use material with flexibility & strength	-Easier to break
Other	-Large MOI (very forgiving) -Low/rearward COM			-May hit ball too far for urban golf

Table 1

Valuable information was gathered using this SWOT method on how this design could lead to new designs optimizing the club for urban golf. Some major takeaways are in the turbulator fins that are shown in **Figure 38** and the club body shape and structure.



Figure 38

The turbulator fins are an intriguing feature that has been proven to increase the club head speed by approximately 1 mph resulting in more distance for the ball and can be added to virtually any club no matter the shape. The club body is a very large hollow structure that is not ideal for urban golf as it will dent easily on ground impact. However, if this shape could be reduced in size and a strong internal structural design added, along with keeping the very forgiving location of the COM, then both the long distance properties of drivers could be merged with the strength and forgiveness of irons and fairway wood style clubs (Kozuchowski, 2014).

Due to the weaknesses of drivers as discussed above, athletes often choose clubs that are less effective launching the ball far but offer greater strength. Fairway woods are a good example of a club that offers these characteristics and has a good balance of both strength, accuracy, and distance (Shot Scope, 2021). A likely club that an urban golfer would use for a tee shot was on sale for \$67 on callawaypreowned.com and is the Callaway X Series N 415 fairway wood shown below in **Figure 39**.



Figure 39

This club is substantially smaller than a typical driver but is designed to be the best club in a golfer's bag in terms of distance second only to the driver. Again the individual components were analyzed separately and a SWOT analysis completed, shown in **Table 2**.

	Strength	Weaknesses	Opportunities	Threats
Club Face	-Strong -Less chunky shots	-Smaller surface area	-Will not “dig” into concrete	
Club Body	- Smaller than driver less impact force with ground	-Hollow structure (weak) -Less force into ball		-Could dent easily
Hosel	-Stronger than adjustable hosel	-Weak connection to shaft compared to steel	-New manufacturing could add strength	-Breaking on impact

Shaft	-Graphite shaft for speed/flexibility	-Weak compared to steel	-Use material with flexibility & strength	-Easier to break
Other	-Can be used in rough, fairway, and tee shot	-Hard to hit -Less control than iron		-May hit ball too far for urban golf

Table 2

The fairway wood is an excellent combination of strength and distance but still may be susceptible to damage. The hollow structure helps increase distance but also makes the club vulnerable to dents and damage which is a major issue when hitting off hard surfaces like concrete even if the ball is on a tee. The decreased size as compared to the driver is a good quality as it reduces the impact force with the ground but also decreases the distance.

Hybrid clubs are another excellent example of what could work in urban golf and therefore were also analyzed as a market competitor with the SWOT method. Hybrids are, as the name suggests, a combination of an iron and a fairway wood. These type of clubs are most notably characterized by their club heads which are larger than that of irons but typically smaller than fairway woods (DICKS Pro Tips, 2021). A hybrid club was found on intheholegolf.com on sale for \$70 named the Taylormade Burner Rescue Hybrid (**Figure 40**). Again, this club was chosen off a second-hand club website because it is a likely location that urban golfers shop to stick in line with urban golfs theme of saving money and current mentality of using older clubs. Again the SWOT method was used to analyze this club and shown in **Table 3**.



Figure 40

	Strength	Weaknesses	Opportunities	Threats
Club Face	-Cuts through rough -High launch angle	-Creates high spin on ball		-Could hit electrical lines/buildings

Club Body	- Small contact area with ground -Looks like a wood	-Decreased distance compared to wood	-Add internal structure	-Could dent easily
Hosel	-Stronger than adjustable hosel	-Weak connection to shaft compared to steel	-New manufacturing could add strength	-Breaking on impact
Shaft	-Graphite shaft for speed/flexibility	-Weak compared to steel	-Use material with flexibility & strength	-Easier to break
Other	-High MOI (forgiving) -Versatile	-Less control than iron	-Can be hit in more situations	

Table 3

Learning from this analysis, it can be derived that the hybrid club is the best option of the ones listed for the tee shot in urban golf. It is easier to hit compared to a wood and the shape of the club reduces impact with the ground (Independent Golf Review, 2022). Although the material and internal hollow structure still leave it vulnerable to damage. To minimize the damage to the sole an alternative material as the sole will fix this problem as well as making it modular to allow for replacement if damage to club does become too great.

Irons

The iron will be used for the approach shot and therefore endure the most impact with the concrete and other surfaces therefore when analyzing other products. The club must be made with high abrasion resistance to prevent scratching and extend its lifespan but still offer quality ball control so the athlete may hit it accurately to their desired distance. With these characteristics in mind and staying true to the urban golfers second hand club shopping habits unique clubs were chosen, shown in **Figure 41, 42, 43** and analyzed in **Table 4**.



Figure 41
PING EYE 2(1983)
\$25/set



Figure 42
Cobra 3100 I/H Irons(2005)
\$75/set



Figure 43
Taylormade Milled Grind(2017)
\$180/3clubs

	PING Eye 2 Irons	Cobra 3100 I/H Irons	Taylormade Milled Grind 3 Wedges
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Strengths	-Stainless Steel heads -Cavity back -High MOI -Low price	-Stainless Steel heads -Low/deep COM -High trajectory (straight) -Large sweet spot	-Carbon Steel -Microrib structure -Unplated face for rusting
Weaknesses	-Weak hosel weld -COM location -High Friction -Age	-Less power -Metal strips fall off -High trajectory (distance)	-Soft face -Blade design (chunking) -Price
Opportunities	-Utilize steel -Improve manufacturing -Use retro look	-Improve manufacturing -Use retro look	-Different plating -Alter bottom texture -Extend back (MOI)
Threats	-High abrasion -Hosel weld breaking -Age altering performance	-Metal strips flying off -Very high abrasion -Change of COM over time	-Rusting shortening life -Microribs creating too much spin -Blade creates greater impact w/ground

Table 4

The steel in all these clubs is important to reference as it is a very strong material, however, it has a relatively low abrasion resistance especially with the high forces seen in a golf swing. To help prevent the damage to the clubs' sole an alternative material that can be replaced will be used to increase the abrasion and impact resistance similar to the driver while maintaining the same performances the clubs analyzed have in terms of ball impact.

Putters

Putting in urban golf may be the most drastic difference in the game when compared to traditional golf and leads to many challenges when considering a putter solution. The holes are unique in the fact that they are not usually holes and requiring the ball to roll on a very uneven and unpredictable concrete surface. With this in mind, unique products were chosen to analyze and are shown below in **Figure 44**, **Figure 45**, and **Figure 46** with corresponding SWOT analysis in **Table 5**. The clubs chosen are limited in their components and therefore the strengths, weaknesses, opportunities, and threats were consolidated and analyzed as they pertain to the product as a whole rather than its' individual components.



Figure 44

Yuma Hybrid Chipper
\$199 new



Figure 45

Siteline Chipper
\$130 new



Figure 46

Odyssey Toulon Putter
\$380 new

	Yuma Hybrid Chipper	Siteline Chipper	Odyssey Toulon Putter
Strengths	-Low loft (low targets) -Large Sweet Spot -Less chunky than wedges	-Alignment features -Less chunky than wedges -Lower loft than Yuma	-Blade design -Face grooves for control -Good balance -Uses back face to pick up ball
Weaknesses	-Low loft (high targets) -Ineffective rolling ball -Poor aesthetics	-Ineffective rolling ball -Poor aesthetics -Low loft (high targets)	-No loft -Price -Limited alignment properties -Smaller club face
Opportunities	-Increase size -Optimize loft -Adjustable loft	-Utilize alignment system -Utilize square design for accuracy -Adjustable loft	-Utilize back face for chip shots -Utilize COM for balance -Adjustable loft
Threats	-Cannot finish holes that are on the ground	-Unable to reach holes that are on the ground -Unable to reach high targets	-Unable to reach high targets

Table 5

For the Yuma Chipper and the Siteline Chipper these clubs are in fact not classified as putters but are included in this research for they possible abilities to perform well in urban golf. These two clubs have a very low loft compared to typical wedges that usually do not have lofts lower than 43° (TGW, 2022). In comparison, the Yuma Chipper and Siteline Chipper have lofts of 37°

and 35°, respectively. This is important to note since the more the loft is decreased the more it begins to look and perform as a traditional putter so that it keeps the controlled smooth feel of a putter but with some increased loft. The Odyssey Toulon Putter was the only classified putter to be analyzed and was chosen for its' highly renowned balance and feel but as well for its' blade design with integrated alignment system. When putting, whether for urban or traditional golf, accuracy is of utmost importance and therefore the alignment systems of both the Sitrine Chipper and Odyssey Putter can be good benchmarks of how to design a putter that will promote accuracy. As well, the Odyssey Putter has an optimal weight balance that will be good to analyze to provide a well-balanced club. Combining aspects of all these clubs will provide an ideal club for urban golf that will allow the golfer to feel like they are holding a putter with its control but make the ball slightly bounce across the ground with its higher loft which helps with accuracy as rolling a ball on uneven concrete is unpredictable but giving it a slight bounce makes it substantially more accurate.

Balls

For the golf ball that will be designed and utilized in the final collection the most important factor is that it will not cause damage to the surroundings but also offer a familiar feel to the ball the athletes are currently using with improved performance. The tennis ball, Almost Golf ball, and Titleist Pro V1 have already been discussed as benchmark products but will be analyzed further as they are the tennis and Almost Golf balls are the current solutions for the sport but offer limited performance or aesthetic advantage while the Pro V1 offers optimal performance qualities with no damage prevention or aesthetic consideration. This further analysis **Table 6** looks individually at each component of each ball to determine what does and does not work with the current design and what qualities may be pulled out to use in the design for this project.

	Penn Tennis Ball \$2.33/ball	Almost Golf Ball \$3.333	Titleist Pro V1 \$5/ball
Strengths	-Soft felt -Large compression (less damage) -Soft rubber interior -Large target to hit	-Real golf ball look -Single material -Soft foam (less damage) -Dimpling pattern	-Dimpling pattern -Multi-density core -High short game spin -Low long game spin
Weaknesses	-Felt tears easily -Large volume (high drag force) -High moisture retention	-Very lightweight -Reduced distance -Abrasion resistance -No protective cover	-Very hard -Poor rolling mechanics -Distance may be too far for urban golf
Opportunities	-Fill in hollow interior -Utilize soft felt feel -Manipulate weight to fly further	-Increase weight -Change core -Add layers -Improve branding	-Alter materials by layer -Smoother surface -Softer core

Threats	-Short lifespan -Weather may render it unplayable	-Falling apart mid-game -Short distance -Easily lost in city	-Breaking windows -Going too far -Losing ball
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Table 6

These balls all offer important qualities that could lend themselves to an ideal urban golf ball but all as well have fundamental flaws that must be altered to allow that to happen. The tennis ball is effective in not breaking windows and causing damage as well as being easily found due to its’ size and color but the material and interior shape of the ball creates serious problems. The felt and interior structure allow for very high moisture retention which makes it nearly impossible to play in rainy or wet conditions. For the Almost Golf Ball it is arguably even more effective in preventing damage since the weight is less than that of a tennis ball and uses a uniform foam material throughout its’ design that absorbs shock well. However, with this ball its lightweight property also means the distance it can travel is reduced creating issues for the athlete on longer holes when maximum distance is required. The Pro V1 in contrast to the previous two will most certainly cause damage if used in an urban environment but its multi-density core is a very intriguing idea that could be used as inspiration to create an ideal urban golf ball. Using this multi-density idea with materials that are used in the foam ball the performance of the ball will be increased while continuing to prevent damage.

Testing Plans

To ensure the products to be created function properly and perform to the expectations set within this project as related to the problem statement, quantitative testing will be conducted. A testing plan is designed to observe the durability, ball flight statistics, and impact characteristics of the three club types as well as the ball to be used. This testing plan was conducted with the baseline products and compared to prototypes of the future products to identify and validate the key performance attributes.

Durability

Durability testing is most essential in the driver and iron clubs to ensure the products will be able to withstand the impact against the hard surfaces that are prevalent in the urban environment. This testing was done in three parts to determine the abrasion resistance, impact resistance, and the coefficient of friction to show that the new materials that will be used in the sole of the club will wear down slower than the baseline steel and as well be able to slide across the pavement rather than stick in the ground and create an uncomfortable swing. Abrasion and impact resistance are mainly focused on the type of material used and therefore the material properties can be simply researched and recorded. The sand slurry test is a standardized test that is used to determine a materials resistance to abrasion (lower score = better resistance) and is the test that was studied to find materials that could offer better abrasion resistance to steel. When analyzing options it was found that UHMW (Ultra High Molecular Weight Polyethylene) exhibits a much lower score of 15 when compared to carbon steel that scored 100 (Bergstrom Skegs, 2023). It is also extremely impact resistant as it had “No Break” in an Izod impact test (Interstate Plastics,

2023) and “has the highest impact strength of all the polyethylenes and will outwear carbon steel 10 to 1 in some applications” (CRG, 2023).

For the friction testing, material samples, a non-stretch cord and rough concrete slab, force meter, and scale were utilized to obtain results. All samples having relatively the same surface area and leading edge were pulled across a rough concrete slab by a cord attached to a force meter and the peak force was recorded. Using the scale to determine its mass, the coefficient of friction was calculated and found that UHMW had a coefficient of 0.55 while steel had a 0.73 proving that the UHMW plastic will more effectively slide across the concrete while being swung rather than stick into the ground creating poor shots.

Loft Testing

In the new putter design a higher loft will be utilized to more effectively bounce the ball across the unpredictable and uneven streets rather than roll, while still having a traditional putter weighting/feel. To test this, three prototypes of different lofted putters (3°, 10°, 20°) were 3D printed and used with the baseline ball on a practice putting green. A small bump was placed between the ball and the hole to test if the ball could be lofted over the obstacle with multiple putts performed with each club to determine the effectiveness to hit the hole and get over the bump. The traditional putter performed, as expected, the worst, by hitting the bump each time and therefore, extremely inaccurate. The 10° lofted putter was able to get over the bump some of the trials but not consistently as it hit the bump multiple trials resulting in inaccurate putts. The 20° lofted putter made it over the bump consistently and did not come off the club feeling like a wedge according to test subjects which is important in both being able to bounce the ball while still maintaining the “putter feel”.

Ball Flight

To test the ball flight, a golf simulator was used. The simulator was used in repeated trials for all prototypes that were made with varying combinations of rubber cores and foam covered balls to find a ball that most effectively launched off the club. Specifically, the smash factor was analyzed which can be calculated as the ball speed divided by the club head speed at impact which shows how well energy is transferred into the ball. Multiple trials were averaged and showed that the best prototype showed a 6.7% improvement compared to the baseline foam ball. This proved that with similar swing speeds, the prototype ball will go faster, therefore farther, as compared to the baseline.

As well, wind testing was conducted to show that the ball will be less affected by the weather conditions when being played. The prototype that tested best in the simulator was 69% heavier than the baseline foam meaning that once hit (assuming the same speed) it will have more momentum and therefore would require a larger wind force to slow it down or alter its flight. The wind testing proved this theory as the prototype and baseline were suspended in front of a fan that was turned to the same speed. Video recording showed how far back each ball was blown and clearly showed the prototype ball was less affected which proves the momentum theory.

Impact

The impact results of the balls are another study that must be conducted to ensure the prototype ball to be designed meets the same standard of damage control as the balls used now if not to be

improved. Using ANSYS LS-DYNA software the hardness values of the core and cover of the prototype ball were used in impact simulations against glass (easiest material in cities to fracture). A ball speed of 200 miles per hour was used in the simulation which was much larger than any trial in the simulator to allow for a factor of safety. The simulation results showed that there is no fracture to the window and that at exceptionally fast speeds windows will still be safe if a bad shot is hit and comes in contact with a window.

The Design Process

With all relevant research completed and testing done, the author worked to design, manufacture, and gain validation with works like prototypes. That process was documented and visualized through the images below that summarize the design, technologies, testing, and marketing/branding that was implemented into this project.



1900's

Golf is largely controlled by private clubs and high society

Expensive Green fees and equipment become a barrier for entry

1980

Platzreife: A license that is required to play golf is implemented in Germany

1990

"Natural Born Golfers" take golf to the streets inventing Urban Golf



THE SPORT.



Estimated 20 Thousand Athletes in France

Paris launches first permanent urban golf course in 2022

World Urban Golf Cup est. 2013

11 participating countries in 2022

37.5 Million Americans Played Golf in 2021

33% "Off - Course" (12.4 million)
67% "On - Course" (25.1 million)



THE SPORT.



URBAN GOLF

FREE

FUN



AGE
21-45

EXPERIENCE
Amateur



URBAN GOLF

Young and competitive individuals looking to learn, practice, and compete in golf with small investment

THE SPORT.



ENVIRONMENT

ENVIRONMENT



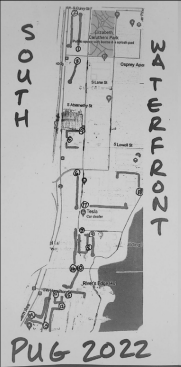
THE SPORT.



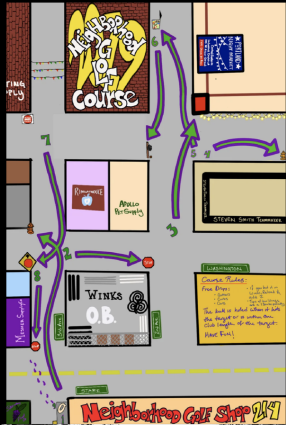
RULES

- 01. Play It Where It Lies
- 02. Holes Marked Before Tee Off
- 03. No Trespassing
- 04. Fewest Strokes to Hit Hole Wins

RULES



1	TRASH CAN	PAR 4							
2	55 GALLON DRUM	PAR 4							
3	PERMIT REQUIRED	PAR 3							
4	AROUND THE CORNER	PAR 4							
5	ABANDONED CAR	PAR 4							
6	TROLLEY TIME	PAR 4							
7	UNDERGROUND PARKING	PAR 4							
8	LOW CEILING	PAR 3							
9	LET THERE BE LIGHT	PAR 4							
10	OTHER SIDE OF TRACKS	PAR 3							
11	U TURN	PAR 3							
12	GOOOOOOAL!	PAR 4							
13	UPS DELIVERY	PAR 4							
14	RENT A CONTAINER	PAR 5							
15	FIX THAT LIGHT	PAR 3							
16	UP AND OVER	PAR 4							
17	BETWEEN THE BUILDINGS	PAR 5							
18	FIGHC BY THE RIVER	PAR 5							
1	2	3	4	5	6	7	8	9	IN
10	11	12	13	14	15	16	17	18	OUT



THE SPORT.



ATHLETE INSIGHT

How Many Clubs Do You Use?

"Usually five or six but ideally three or four"

Problems with Current Ball Solutions?

"Cannot reach the longer holes"



Problems with Current Clubs?

"They get scratched and lose their performance which we care about but most just want something different"






THE SPORT.



	Under \$3/ball	Fly 100yd	"Safe"	Durable
	X		X	
	X		X	X

THE SPORT.



	Under \$100	Unique	Versatile	Durable
 Classic Wood	X	X		
 Steel Iron	X		X	
 Putt/Chip Combo		X	X	

THE SPORT.



HOW CAN WE...

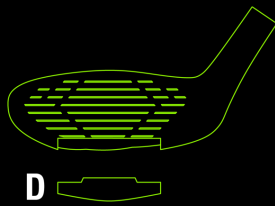
create a set of clubs and ball to help urban golfers improve performance and maintain safe play while withstanding the impact against pavement

THE PROBLEM.

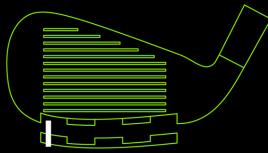


1-13

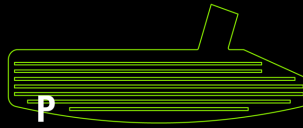
PRODUCT LINE



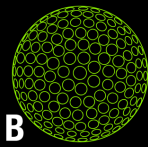
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THE PROBLEM.



INSPIRATION

MOOD BOARD



DESIGN



SKETCHING

DESIGN



SLIDE SOLE.

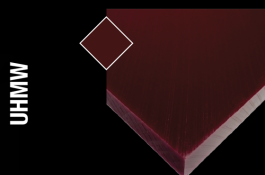
NEW TECHNOLOGY

A high impact/abrasion resistant modular club sole to extend the life of the club

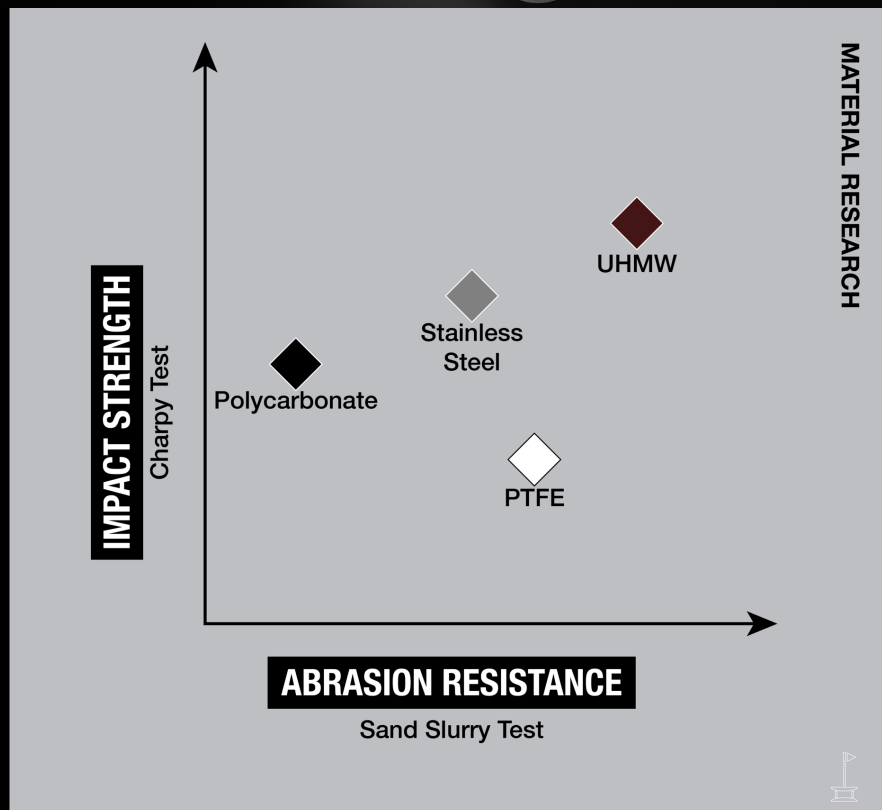


NEW TECHNOLOGY

SLIDE SOLE



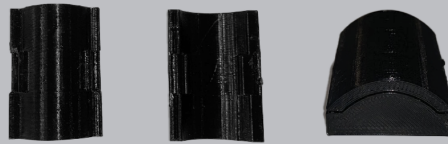
SLIDE SOLE



IDEATION



SLIDE SOLE



PROTOTYPING

IDEATION PROTOTYPING



- 1 High impact/abrasion resistant plastic for extended life
- 2 Snap Fit design for ease of sole replacement
- 3 Low and extended COM for increased forgiveness

- 4 Variable face thickness for increased MOI and forgiveness

SLIDE SOLE

DRIVER



IRON



- ① High impact/abrasion resistant plastic for extended life
- ② Snap Fit design for ease of sole replacement
- ③ Low and extended COM for increased forgiveness

SLIDE SOLE

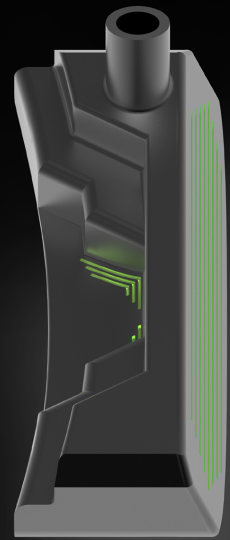


LIFTED.

NEW TECHNOLOGY

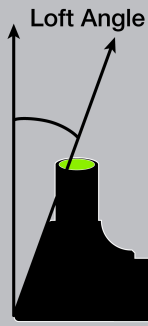
NEW TECHNOLOGY

A high lofted putter optimized to allow the ball to bounce effectively on concrete while maintaining a smooth putting motion



LIFTED





LIFTED Putter
20°



Typical Putter
1°- 3°

Current putters roll the ball which can be ineffective on surfaces like cracked roads and brick

LIFTED allows the ball to bounce along the street while maintaining the familiar smooth feel of a putter

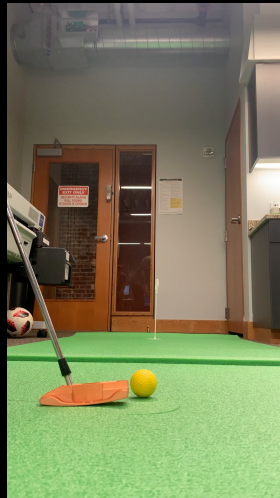
LIFTED



NEW TECHNOLOGY



3°



10°

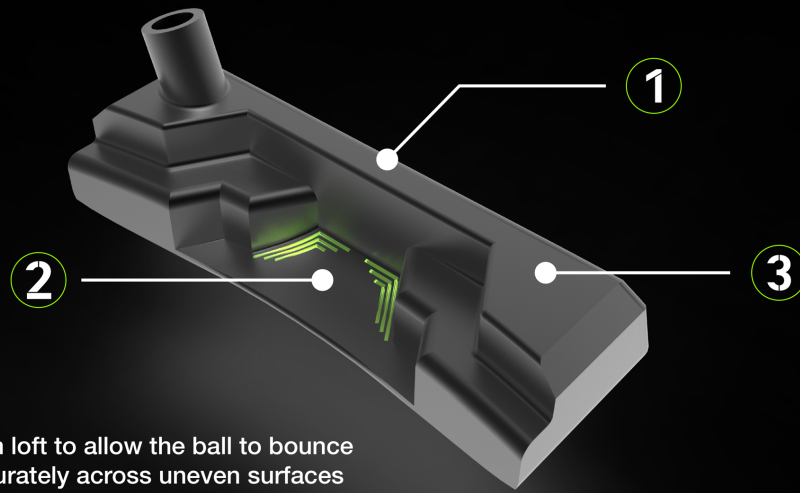


20°

LIFTED

TESTING





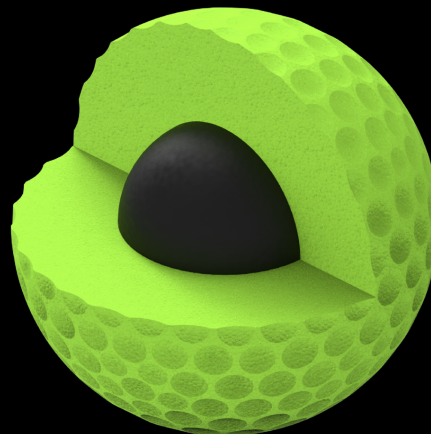
- 1 High loft to allow the ball to bounce accurately across uneven surfaces
- 2 Rear scoop design to allow for ease of ball pick up
- 3 Perimeter weighting for a controlled putting stroke

LIFTED



NEW TECHNOLOGY

MD BALL.

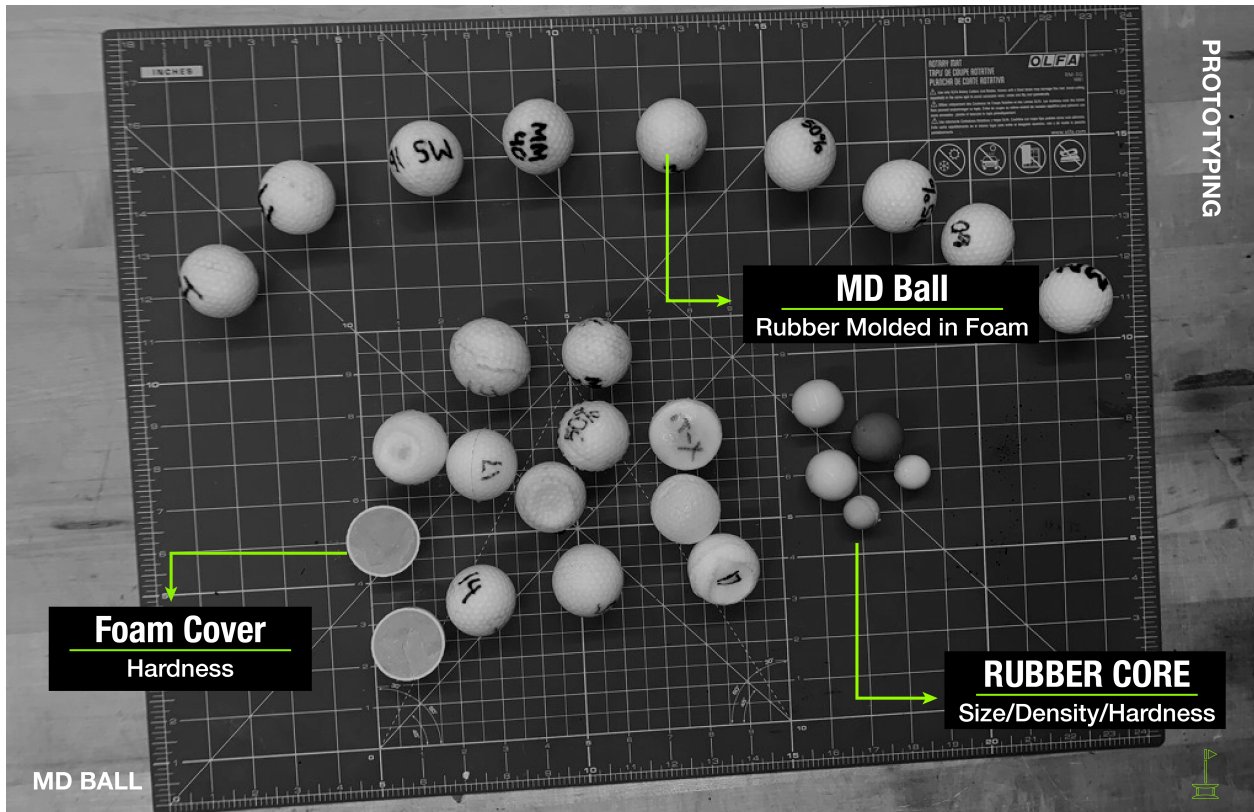


NEW TECHNOLOGY

A multi-density foam ball with rubber core that improves performance while preventing damage

MD BALL






PROTOTYPING

MD BALL

TESTING

Simulator Testing



6.7% Improvement

SMASH FACTOR = BALL SPEED / CLUB SPEED

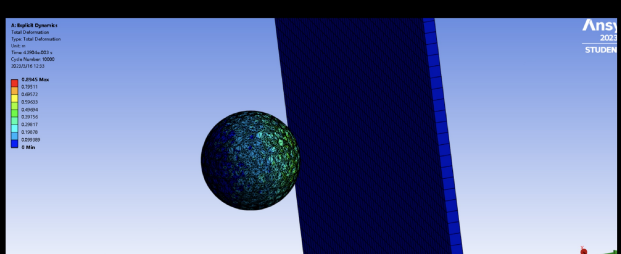
Wind Testing

Baseline
10 grams

Prototype
16 grams

NO BREAKAGE

ANSYS IMPACT SIMULATION



TESTING

MD BALL

"This honestly is more fun than normal golf, these clubs just make it even better"

"A putter that can skip the ball would work great for out here"

"We could definitely make some fun holes if the ball is able to travel farther"



"These could definitely help grow the sport"

ATHLETE VALIDATION



Using an advanced foam ball and eliminating the need to use worn out clubs the **CURB** collection helps urban golfers play better, growing their confidence and love for the game



VALIDATION





PHOTOS

FINAL CLUBS



PHOTOS

FINAL CLUBS



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