Caddy Grips

by

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Abstract

With the rise and fall of Tiger Woods, the sport of golf has been in a critical juncture where it needs to find innovate ways to not only maintain interest but increase participation in the game. This paper is a brief examination of the history of golf and an exploration into the issues faced by the sport. A solution to these problems is presented as a suggestion to expand on the current state and features of distance measuring devices. After recapping what distance measuring devices are capable of and adding in other existing technologies, the conceptualization process is reviewed. Undergoing a least resistance design process for a new form of distance measuring device, a two-part solution is fabricated. Each step of the design process is covered from the user research, development of prototypes, and testing, up until the feedback-driven revisions are made. The paper concludes with final thoughts and potential next steps to take the idea from design into development.

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Chapter 1: Background

An Early Beginning

Tracing back to Scotland in 1457, golf is one of the oldest and most popular sports in the world (Geddes, 2007). While not the first "stick and ball" sport to ever be invented, golf is certainly one of the older sports still around. It not only is old, but the game "plays old" - meaning, golf can be played by the youngest of young and the oldest of old. If you are able to walk and swing a club, you can play golf. Unlike other sports such as football, baseball, basketball, soccer, or tennis; incredible amounts of strength, speed, or endurance are not a requisite of golf. Frequently one can find young children accompanying their parents on the course or a foursome of senior citizens enjoying an afternoon together.

Over the next 500 years, golf began to become more popular and widespread globally. With this growth, the sport's rules became more standardized as major tournaments were scheduled into the yearly season and a ranking system was generated to help better establish who the best players in the world were.

Golf had always been a distant afterthought in interest and attention for much of the country. It wasn't due to lack of skill. Players like Arnold Palmer, Jack Nicklaus, Gary Player, Ben Hogan, and Bobby Jones all provided great entertainment for those that watched the sport. The problem was they all fell into the same demographic. The stigma for a very long time was that golf was a sport for old, rich, and white men to watch rich and white men compete in. The sport needed a dynamic personality to increase its popularity and participation rate. On the very last day of 1975, a solution was born.

The Tiger Effect

For this generation, there is a consensus greatest golfer of all time - Tiger. "Golf pundits can debate whether Woods or Jack Nicklaus was the better golfer for the next 100 years, but there's no debating who was the most influential golfer of all time" (Simpson, 2014). Further, Elrdick "Tiger" Woods is perhaps the most important athlete to any sport in mankind's history. Tiger can be found toward the top of many lists ranking the most

impactful, important, or influential athletes of all time. In 2013, the chief writer at Bleacher Report ranked Tiger fourth most influential current athletes stating that Tiger was "responsible for helping take the game of golf from a perceived 'old man's sport' that no one under the age of 30 played" (Dimengo, 2013). Another list ranks him third of all time behind respective basketball and tennis legends, Michael Jordan and Roger Federer. "Tiger is one of the most successful golfers of all time. He was also cited as the highest paid athlete for several years according to Forbes magazine. [H]e first reached the number one position in the world's rankings [and was] the youngest person ever to do so" (Khatoon, 2013). When you begin to drill down on the facts, this statement is hardly hyperbole. Breaking the sport down into six different categories – driving, putting, short game, bunker play, iron play and mental game – 30 PGA Tour players Golf Digest ranked Tiger the best of all time in two, putting and mental game. In the words of Stewart Cink, "Tiger Woods is the best clutch putter I've ever seen" (Stafford & Myers, 2016). In regards to his mental game, Heath Slocum said, "I've never seen anything like it" (Stafford & Myers, 2016).

Tiger Woods has "changed the game in 3 major categories - Tour Money, Globalization and Talent Level" (Golf Newz, 2011). With his electrifying personality, his aggressive play style, and his ability to make crucial shots in the clutch, not just America, but the world took to Tiger with open arms. In a sport as "boring" as golf, he was being likened to Michael Jordan, a similarly gifted athlete in the much more popular sport, basketball. Both were featured in many famous Nike commercials, however, their two most iconic came in the 1990s. Jordan had kids and adults wanting to "be like Mike" while Tiger had everyone proclaiming "I am Tiger Woods" (Rovell, 2016; Fonseca, 2015). His fellow players can certainly thank him for the increase in prize money and overall earnings, but the other two previously stated categories had the greatest impact on spectators and amateur golfers around the world. After quickly signing a deal with Nike in 1996, kids were no longer just trying to "be like Mike" but also proclaiming they "were Tiger Woods".

"Tiger Woods changed the game and interest in it," said Pat Rishe, professor of sports economics at Webster University in St. Louis. "We got spoiled by all he did when he was winning. He created a spike in golf that we're unlikely to see again" (Koba, 2014). Popularity in golf rose across the world. The greatest gains were in "Asia, the Middle East, South and Central America and Australia" (Golf Newz, 2011). Until Tiger's rise to greatness, these parts of the world rarely participated in the sport. Golf was born in Europe then found its way into North America. Not only that but inside of the States, Tiger garnered interest in the game among minorities, particular among the African American and Asian American communities, which had previously been virtually non-existent. The correlation between the exponential growth in popularity in the other areas of the world and Tiger's success can lead one to argue that Tiger was able to accomplish what 600 years of sport history was incapable of doing prior to his arrival. But as the saying goes, "all good things must come to an end."

Recent Decline

On November 26, 2009, Tiger's life and perhaps consequently the direction of golf's popularity would abruptly begin to decline. On that day, Tiger's ex-wife physically confronted Tiger over confirmation allegations that he had been unfaithful to their marriage, with several different women (Callahan, 2013).

Coincidentally or not coincidentally, Tiger began to see rapid deterioration in his body. Between chronic back problems and numerous knee injuries, Tiger was hardly able to stay healthy to finish tournaments consistently. Experiencing only three documented injuries prior to the November 26, 2009 incident, starting in 2010, Tiger began to be plagued with injuries to his neck, Achilles, knee, elbow, back and even glutes every year since (Golf Channel Digital, 2016).

When he has been able to finish rounds, his play has never been able to consistently reach the unprecedented standard he built during his meteoric rise. He has never won a Major tournament since that infamous night (AFP, 2015). While this level of success would be good enough for 99% of the golfers in the world, Tiger's standard was Tiger's standard - extremely high. Tiger's goal since joining the pro tour was to pass Jack

Nicklaus record of 18 career Major tournament wins and become the best the world has ever seen. Tiger was on track and ahead of pace to eclipse Jack to the point that it wasn't if he was going to surpass Jack but when. With the seven year anniversary of Tiger's scandal, the question is not if Tiger can win five more to pass Jack's 18, but it is now is if Tiger will ever win another Major again since his last of the 2008 US Open (AFP, 2015). To ask Tiger, he still believes he can. "I think his [Jack Nicklaus's] major championship record is certainly still attainable," Woods told reporters at a media day for the PGA Tour's Quicken Loans National tournament that he hosts at Congressional Country Club in Maryland (Hodgetts, 2016).

"The decline in golf's popularity coincided with Woods' 2009-2010 infidelity and divorce and recent physical ailments, said Rishe, and so has a lot of enthusiasm for the average person to pick up the game" (Koba, 2014).

Of course this decline has not gone without others trying to take the figurative throne that Tiger has unwillingly began to relinquish. While no one has been able to capture the magnitude of the combination of Tiger's global notoriety, uncommon marketability and sustained success, many young talented golfers are beginning to emerge and make names for themselves. Rory McIlroy, Jordan Spieth, Jason Day, and Rickie Fowler have all enjoyed varying levels of success in the past seven years since the beginning of Tiger's demise. And fortunately for the sport, all of these players are no older than 28, with Spieth being only 23, suggesting they will be around for at least another decade. Golf just needs one or two of them to begin to separate themselves from the pack a la Tiger so the marketing machine can sink its teeth into its best prospect. Now, "perhaps golf needs a new Tiger in its tank" (Koba, 2014). Bob Dorfman, the executive creative director of Baker Street Advertising, added, "The game definitely needs more rising stars in the Tiger and Phil mold to bring in the casual fan and grow the game's popularity" (Crouse, 2015). It just may already.

A Need for Modernization

Of course, all hope can't be lost. For the sake of the sport, it can't accept this fate. Sports have to evolve to stay relevant. Whether it is through rule changes, like the

National Football League's recent rule changes to make the game safer and more offensive friendly (NFL, 2010) or the National Basketball Association's rule changes to add a 3 point line in 1979 (Mather, 2016); or the benefit of having a super athlete like a Michael Jordan, LeBron James, Derek Jeter, or Peyton Manning talent to elevate the game beyond what it has seen; or simply through better marketing and advertising to reach out to broader audiences; golf must find its answer.

Though it has always been viewed quite literally as a "gentleman's game" to be played with class and honor, the sport might do well to promote the same audio and visual excitement Tiger once graced the sport with. This is the same excitement one would find turning on a football, basketball or hockey game.

Another area to seek for more sport adoption is to inject technology into the game. Right now, broadcasting channels are able to replay the pro's shots at super slow motion speeds to truly capture the dynamics of a swing and they are able to trace the flight of the ball to better track its path and landing location, otherwise impossible to see at live speeds from through a TV screen (Anderson, 2013). This is a great start but adding technology into an amateur's game would perhaps be even more beneficial.

People like Gadgets

Whether it is from the stories they can tell; keeping up with trends or fear of missing out; the potential to learn or have fun; or simply needing something to spend money on, gadgets have been adopted into our culture (Shaw, 2014). Useful or not, people will continue to buy gadgets of all sizes. Walk by a food court, or into a doctor's office, or look around on a bus, or a concert, or sporting event, or even a school classroom and you'll find people faces buried into a device of some sort. Whether it's a phone, or music player, or both, or something completely different people like to have something to supplement their attention.

Chapter 2: Problem Space

Critiques of the State of Golf

"Unlike other sports, golf doesn't necessarily reflect children of the millennial's values, such as diversity, instant gratification, affordability, and inclusion" (Solomon, 2014). The Economist published an article in 2015 which did a good job of summarizing golf's issues and shortcomings. It summarized them into three reasons:

- "First, golf's calm pace may no longer fit in with modern lifestyles. It can take more than four hours to play a full round of 18 holes. And disappearing to the golf course for half the weekend is not compatible with modern attitudes to child-rearing.

- "Second, while golf may have managed to shake off some of its elitist image, America's troubled economy is once more making it a pursuit of the wealthy. Middle and lower-income golfers have seen their pay packets shrink, hurting membership numbers at mid-range golf courses. Some public courses have been closed by local governments making spending cuts.

- "Third, golf has become harder to play. Since the 1990s golf-course designers have taken to building longer, tougher courses in order to put golfers and their equipment to the test. The sport's growing difficulty and its 200-page rulebook make it a tough sell to new players." (Economist, 2015).

To recap, they identified the issues as being too long or slow of a game, not being accessible for all demographics, and its inherent level of difficulty. These issues aren't entirely unrelated. Advancing the technology of the sport could go a long way in making it faster and easier which in turn will make it enticing for more types of people to try.

One hurdle is a bit more formidable. Cost. Golf course designers and architects have done a great job in crafting the land to not only create challenging courses but utterly beautiful scenes. It's not entirely uncommon for players to expect to play $100 for a round of golf (Stuller, 1997). "The high cost of playing prevents those in low incomes,

such as students or lower middle class families, from playing on both a casual and permanent basis" (Solomon, 2014). "For so many years, golf was a tool for developers to sell property," says Phil Smith, a golf course designer who worked with Nicklaus and Weiskopf during the [Tiger] boom (Greenfeld, 2015).

Another critique from Time echoed the sentiments from The Economist, adding an additional factor to consider. They argued that golf actually isn't in decline and the perception of such is simply an effect of the "golf bubble" garnished by Tiger Woods. Removing the 15 to 20 years of Tiger dominance and looking at the state of golf across its entire historical spectrum, golf is not in as bad of shape as some might think. It was a niche game that benefited from the emergence of a once in a generation superstar athlete and enjoyed irregular popularity. Now that his reign seems to be over, golf has simply returned to its original state (Tuttle, 2014).

In fact, even taking the boom of Tiger into consideration, World Golf Foundation CEO Steve Mona believes the sport is on the rise (Stutsman, 2016). "Golf hasn't seen an increase in popularity like this since 2000 when 2.4 million people began playing. And remember, 2000 was when Tiger (Woods) started peaking" (Stutsman, 2016).

Despite these numbers in the past year plus, others disagree about the shape of golf. Many others have correlated golf's fortune with Tiger Woods'. Bob Dorfman thinks while the major tournaments will continue to do well because of their magnitude and talent pools the non-major tournaments are in jeopardy. "It's the other tournaments that are going to suffer a lot more without having a Tiger Woods playing on the weekend, " Dorman says (Crouse, 2015).

Whether you agree to ignore his impact or not, from golf's point of view, they want to continue to thrive as a popular global sport. And to achieve this, the injection of more technology is a great place to start.

Effects of Technology in Sport

The idea of technology helping the popularity of a sport from a spectator or participant's point of view is not foreign. There are many examples of this concept successfully implemented.

Three of the most popular American sports - football, baseball and basketball - all have made considerable strides in the advancement and integration of technology and sport. Each of these has implemented replay systems which help with rule enforcement and spectator's enjoyment of particularly skillful displays of talent.

These replay systems don't simply play back what was originally broadcasted. Technological advances have afforded opportunities so that often times there will be overlays shown on the screen in real time or in replays. This is done through technologies such as logo-transition detection replay recognition (Tong, Lu, Liu, & Jin, 2004). This allows announcers and color commentators to draw on the screen while live action is taking place. In football it allows the first down lines to show on the field for the viewers at home. It also allows for broadcast stations to display their logo over the replay as they go to commercial.

In perhaps the oldest sport, track and field, laser technology is used to achieve the incredibly precise measurements of time and distance (Goldman, 2014). This goes a long way in determining records as the margins of human error in some cases can decide the difference between a world record setting result and a finish that isn't even first place in the current competition.

"With the rapid increase of media data, it is in urgent need of an efficient and effective method for information management and retrieval" (Tong, Lu, Liu, & Jin, 2004). Technology preserves the integrity of sport and pleases the increasingly statistics-driven spectator mindset. From a player's standpoint, it can completely enhance the experience.

Money to be Spent

There's a great deal of money being spent on golf. "In 2001 the magazine Fortune reported that: 'no one knows how much companies spend on golf each year, but it is clear [that it is] in the billions and rising'" (Ceron-Anaya, 2010). This estimation dates back to around the middle of the Tiger boom. Today, the money is only greater. "Golf adds about $70 billion a year to America's economy" (Economist, 2015). The everyday golfer also spends quite a bit on the game. In a "2009 Survey of the American Golfer" by the Nation

Golf Foundation, commissioned by Golf Magazine, it was reported that amateurs spend nearly $3,000 annually (Barrett, 2011).

Additionally, the players are well paid. Tiger Woods has been one of the highest paid athletes in any sport, ever (TheRichest, 2016). He has had such a profound effect on the sport that he singlehandedly birthed Nike Golf and later his own namesake brand of golf. "The company has invested hundreds of millions of dollars in its golf business over the past decade and sponsorships of Tiger Woods and Rory McIlroy alone cost Nike somewhere around $40 million to $60 million annually. In fact, Woods, who signed a $40 million deal with the company in 1996, was the catalyst for Nike's entry into the club and ball business." (Hoium, 2016)

But not just Tiger, currently the 12th highest paid athlete, enjoys the sport's riches. Three other golfers (Phil Mickelson - 8th, Jordan Spieth - 9th, Rory McIlroy - 17th) rank among the top 20 highest paid athletes according to Forbes (2016). Spectator interest in the game, however, has declined in correlation with Tiger's play. "Turns out many of those people didn't tune in to watch golf, they tuned in to watch Woods." (McFarland, 2016). So the question becomes - how can this money be used to continue to grow the sport as a participant and spectator sport despite the inevitable loss of perhaps its greatest son?

As already stated, modernizing the rules and style of gameplay will help. This, however, is not breaking news. Attempts to make the game faster, easier and more accessible have been made. "By now the various attempts to "save" golf by making the game faster, cheaper, and easier to play have all taken on an air of desperation" (Greenfeld, 2015). Time is of the essence, however. Just as Tiger helped birth Nike Golf, "things [have gotten] so bad that Adidas and Nike are abandoning the game" (McFarland, 2016).

Distance Measuring Devices

In both the "make it easier" and "make it faster" categories are devices designed to help a player determine which club to use next. These distance measuring devices (DMDs) come in two different forms - rangefinders and global position system devices.

While the latter is a much more extensive and feature driven iteration of the former, both attempt to make play easier and faster. Yardage, the biggest determinant in deciding which club to use, can be determined much more precisely with these tools. Most golf courses have yardage markers either on the sides or middle of the fairways. Typically they are found 100, 150, 200, and, sometimes, 250 yards from the flag on the green. When the yardage markers can be easily located it can make the process of determining which club to use fairly easy. However, anybody who has taken a geometry class knows that unless you are in the middle of the fairway aligned with the hole, the yardage is most certainly not exact. Additionally, if the ball isn't sitting exactly at the marker, you are left to estimate up or down; this takes time.

This may not seem like a big deal to someone who has never played the game, but there is a reason why you take upwards of 14 clubs during a round of golf. Clubs are designed to do specific tasks and a club up or down can make a difference of ten to fifteen yards. Ten to fifteen yards can be the difference between putting your next shot and having to chip back onto the green (see Appendix C for golf terminology). Or worse, ten to fifteen yards could be the difference between a ball ready for the next shot or at the bottom of a water hazard. Factoring in where the ball rests (or the ball's "lie") and the inconsistency of an amateur's swing and one can begin to see how golf can be a difficult sport.

Professional golfers are not permitted to use such distance measuring devices. Among the reasons why are that professional golfers are assisted by human caddies. In coordination with the caddies, golfers often play practice rounds before tournaments to familiarize themselves with the course and fill out a yardage book for reference during play (Herrington, 2014).

> "Rule 14-3b of the United States Golf Association's Rules of Golf bans "artificial" devices used for "gauging or measuring distance" or other conditions of play, such as the course's slope or the day's weather. The penalty for violation of Rule 14-3b is disqualification. Yardage books are not considered artificial and are therefore permitted during play" (Rose, n.d.).

However, only the smallest percentage of amateur golfers employ caddies to assist them on the course. Furthermore, amateurs never walk and scout the course the day prior to playing. So to help combat unfamiliarity with a course being played and the absence of a second pair of eyes and decision making, distance measuring devices are used.

Rangefinders can be helpful, but the best way to replicate the advantage of having a human caddy is to use a GPS device. Rangefinders are limited in that they can only show you yardage from the place you are standing. Meaning, any upcoming shots and anything that is out of line of sight or potentially blocked by an obstacle, such as a tree, remains a mystery.

GPS devices provide clarity to many of these issues while offering a wide range of features and coming in several different styles. The most basic forms provide information such as shot distance and distance to the pin. The more advanced versions provide accurate graphical representations of the current hole along with distance to the pin and hole's obstacles. They also can provide insight on the weather and wind conditions and green elevation. Golfers are loaded up with information and features. Many devices now count strokes and keep track of score, as well. These devices come in many different compositions. From viewfinders to handhelds to devices that stay connected to the golf cart. Lately, in unison with the boom of wearable tech, GPS watches or bands have enjoyed a rise in popularity (Keepfer, 2016). "First of all, with respect to GPS devices, they're going the way of wearables" (Kramer, 2016). This is mostly due to the watches being designed to be stylish enough to wear off the course thus eliminating the need to buy a specialized device only used for the few times a month a golfer may be on the course. Sticking to this trend of either making technology wearable or leveraging other systems to combine technologies into one device will only continue as more and more features are added to these tools.

Chapter 3: Design Process

Conceptualization

After taking into consideration the current challenges facing the popularity and barriers of entry to the game of golf, a plan to make things easier and more accessible was devised. Expanding on the existing products in the market and pulling from technology found in other products a concept began to take form. The design goal was to further integrate the advantages of using or wearing a distance measuring device while playing and place the technology in the clubs themselves.

The result, preliminary named "CaddyGrips" is a two part concept – one part physical/tangible, one part smartphone application. As the name implies, the tangible part of the design would be a replacement for the existing grips on a golf set. People often regrip their clubs for a variety of purposes ranging from comfort to typical wear and tear to competitive advantages. This can be taken care of at local golf supply shop while at the same time being easy enough for a do-it-yourself type of person. Incorporating CaddyGrips on a set of clubs would be no different.

Using Radar and Global Positioning System technology in multiple ways, CaddyGrips measures several critical factors about a player's positioning and quality of golf swing to replace many other devices that are being used and not being used by the typical golfer. CaddyGrips vision is to combine existing technology in a groundbreaking way so eliminate outdated approaches and technologies.

First, the club will measure the distance to the current hole and be able to provide suggestions, via the complementary smartphone application, on which club to use. Additionally, hole mapping software, while inform the golfer of potential hazards ahead. While some golf courses provide visual representations of their holes, many are not to scale and none can provide dynamic distance on the fly. Taking guesses, using range finders, and even using GPS devices will no longer be necessary. The club recommendation feature will remove the need to have a second pair of eyes or a paid caddy following you as though you are a professional golfer.

Second, CaddyGrips should measure the speed and shape of the swing along with the point of contact the club head made with the ball. Having this critical information can determine the quality of a golf shot without even seeing the flight of the ball. Also, because each CaddyGrips grip is assigned to a club, it will be able to give proper feedback on the shape of the swing per club as a swing from the driver should look much different than a swing from a wedge. Therefore, the system can provide feedback and accurately explain what caused a poor or quality shot. This information will be fed to the accompanying device so that the golfer may view. This feature is groundbreaking to golf play as this type of feedback is generally reserved for golf shops and high end golf driving ranges. The difference being that those places use external devices to measure, whereas CaddyGrips will have the technology within each club.

Finally, CaddyGrips provide automatic score tracking. After taking practice swings you can activate the CaddyGrips shot tracking feature and the next swing will be counted as a legitimate shot. For each legitimate shot attempt, your score counter will go up until you have confirmed the ball is in the hole. At this point it will cycle to the next hole until the round is over. CaddyGrips will also have the capability to keep track of other members of your group in a more traditional manner. However, if another member has CaddyGrips, you can sync your scores easily. This feature will remove the need for pencil and paper score tracking as well as removing the load of remembering how many shots were taken on a given hole.

Sketches

To better understand the concept, the following figure is a visual representation of how the product would look. It is important to remember that the product's goal is immersion so additional captions have been added to explain the underlying technology.
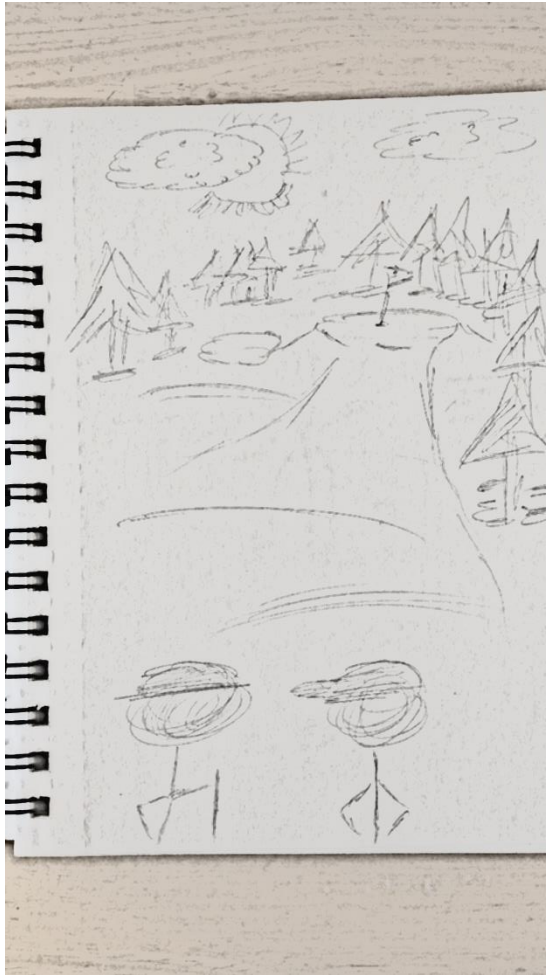
Two golfers begin a round of golf and survey a short par 4 from the tee box (see Appendix C for golf terminology).

After selecting a club, the first golfer activates his CaddyGrips via the club's grip when he is ready for his swing. To acknowledge this request, the sytem makes a low volume "beep."

The first golfer successfully completes his swing as the second watches.
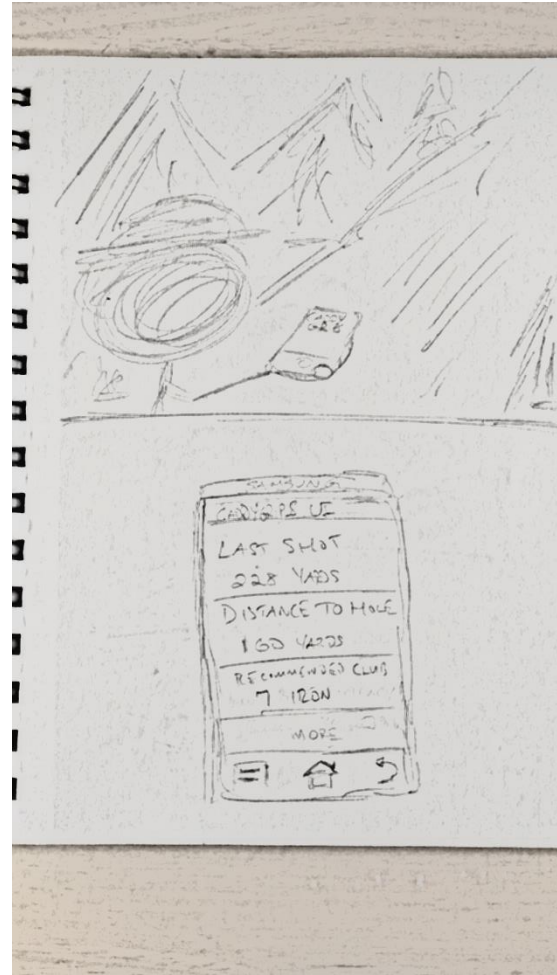
After reaching the ball, the golfer checks his shot distance and distance to the pin via his smartphone CaddyGrips app. The software recommends the club he should use for his next shot.

Realizing he has the wrong club the golfer
heads back to the cart to retrieve the
suggested club.

Figure 1. Sketches of the user experience.

       To accompany the physical design, a smartphone application will be required to capture data via Bluetooth or data connection.

Process Flow

       The following process flow illustrates how a typical hole would be played with CaddyGrips. One thing to notice is that there is not much added action versus playing a hole without CaddyGrips. Additionally, despite this, there is much added value and information prior to and following each shot.

Process Flow: Playing a hole of golf with CaddyGrips
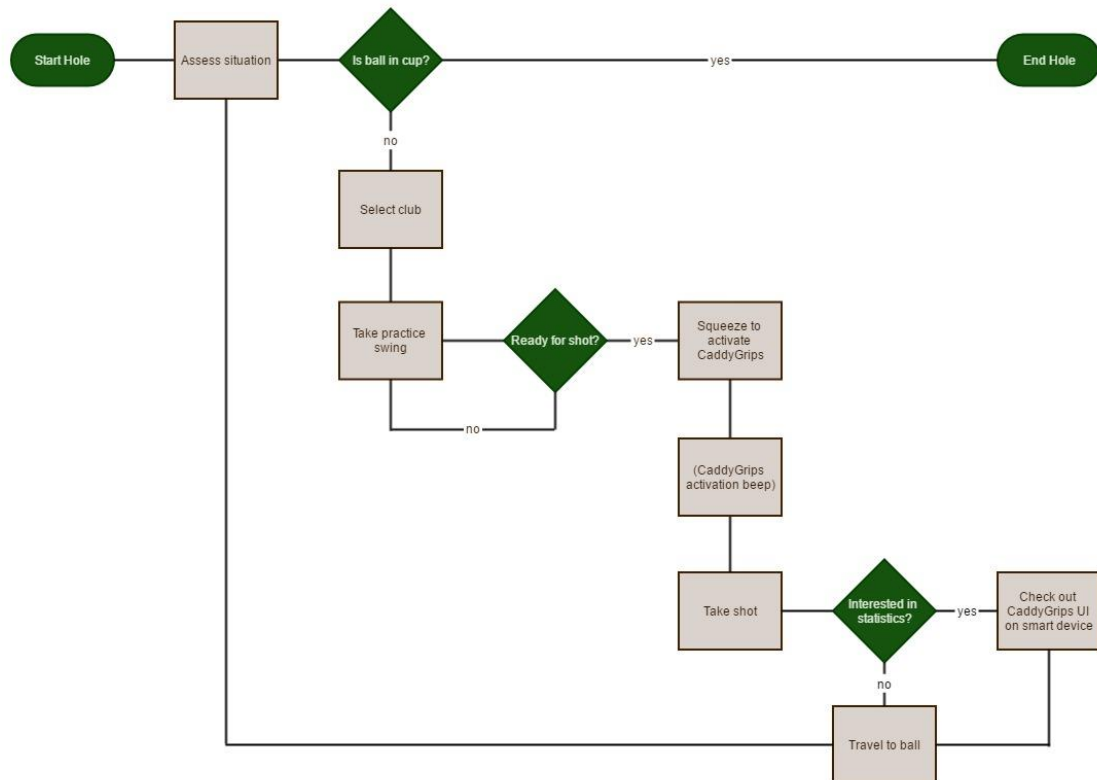
Figure 2. Process flow for application.

Questionnaire

To assist in the calculation of how golfers of all skill levels perceived distance measuring devices, a questionnaire, powered by Google Forms, was distributed to qualifying participants. The requirements for the survey were to be an adult who has played at least one round of golf in their lifetime. A round of golf was defined to be nine holes rather than 18 to allow for those that play the game but haven't committed to the time needed for a complete round just yet. To ensure these conditions were met, the first two questions of the questionnaire were included for validation.

The following screenshots are of the distributed questionnaire. It can be accessed following this URL: https://goo.gl/forms/aybdZzXnaxrIA4Ic2. A printed version can be found in Appendix D.

Questionnaire Results

From the distributed questionnaire, I yielded 28 results. For the raw data, see Appendix A. Each participant was fully qualified based on the two conditions created. The greatest number of participants came from the 26 to 35 years old bracket and the 56 to 65 years old bracket. No participants were 76 years or older. There was representation in skill across the entire handicap (see Appendix C golf terminology) for spectrum with the majority of participants in the moderate to beginner skill levels. A player's handicap is an index used to measure a golfer's potential ability. It is calculated as a summation of a player's average score in relation to a course's par. The follow two figures break down the participant demographics.
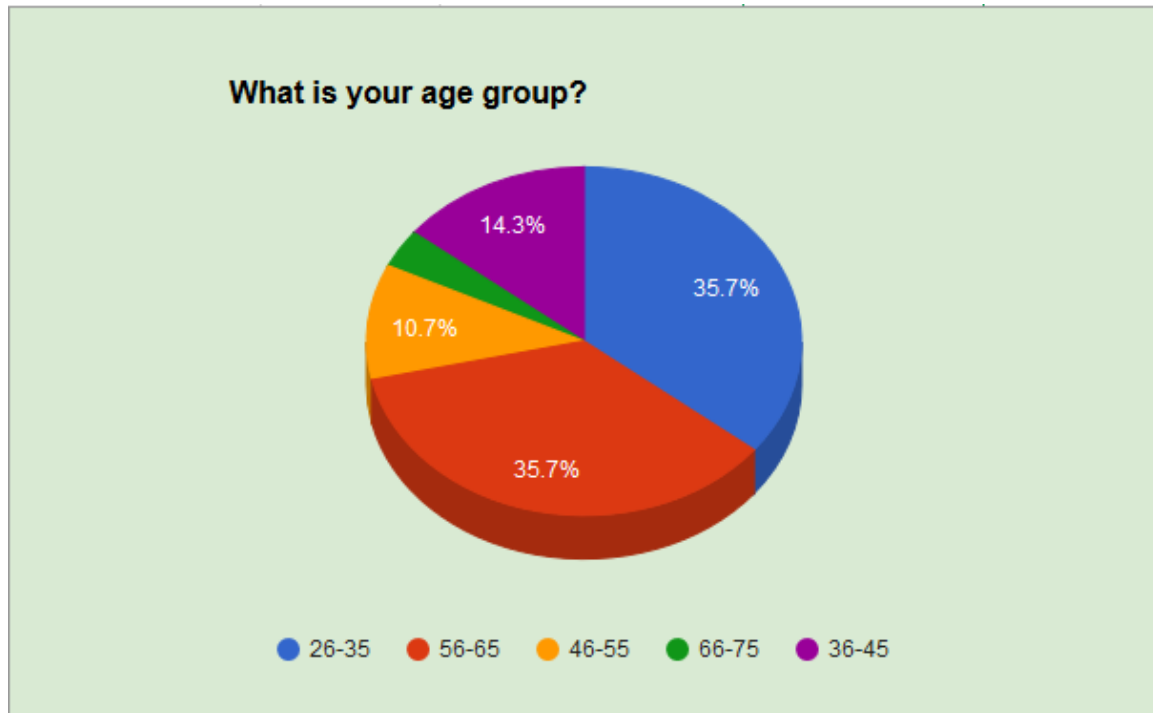
Figure 3. Survey results – What is your age group?
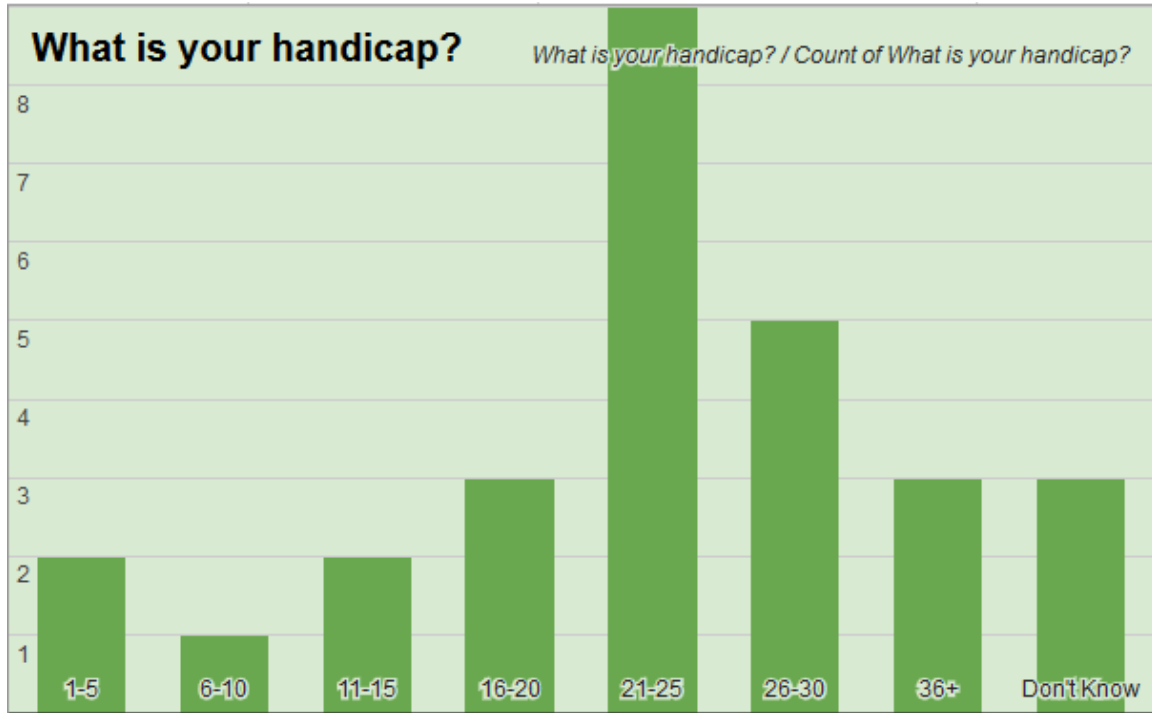
Figure 4. Survey results – What is your handicap?

When asked why a participant has or has not used a distance measuring device, the answers in favor of the tools ranged from "for a competitive advantage" to "helping clarify distances" and "speed up the game". One participant in favor of the devices said, "It speeds up the game, giving at least cursory information regarding distances to and from ball locations. Negates need to search for on course permanent markers." This player had a handicap between sixteen and twenty. Many others mentioned the advantage of being able to more quickly select your next club with the tools. Another simply stated, "I like techie things."

Answers against the use of the devices usually include some sort of traditional mentality and getting a feel for the course with their own eyes. Or, however, simply never hearing of such a device. One participant, whose handicap was between one and five, answered, "I am a bit old school and like to manually determine the distance by using the course markers and by using the color of the flags to determine if I should add or subtract distance based on pin placement. I am not against GPS though. At some courses the carts are equipped with the technology and that is a convenient functionality." Another, weaker

player, handicap between sixteen and twenty, added, "I like to rely on feel rather than a tool. More so, I have played with people who use range finders and I guess within 1 or 2 yards every time." Interestingly though, even those that admit that they would not want to use distance measuring devices, believe that they are useful in improving ones game. Both aforementioned participants answered "A little" to this question. Therefore the decision not to use them might suggest a desire to preserve the game's integrity.

As stated, it is important to understand that regardless of the player's personal opinion on using distance measuring devices or not, most of them agreed that the devices help at least a little. 92.9% of those that were surveyed did. This type of data confirms that there is room for growth in the industry.
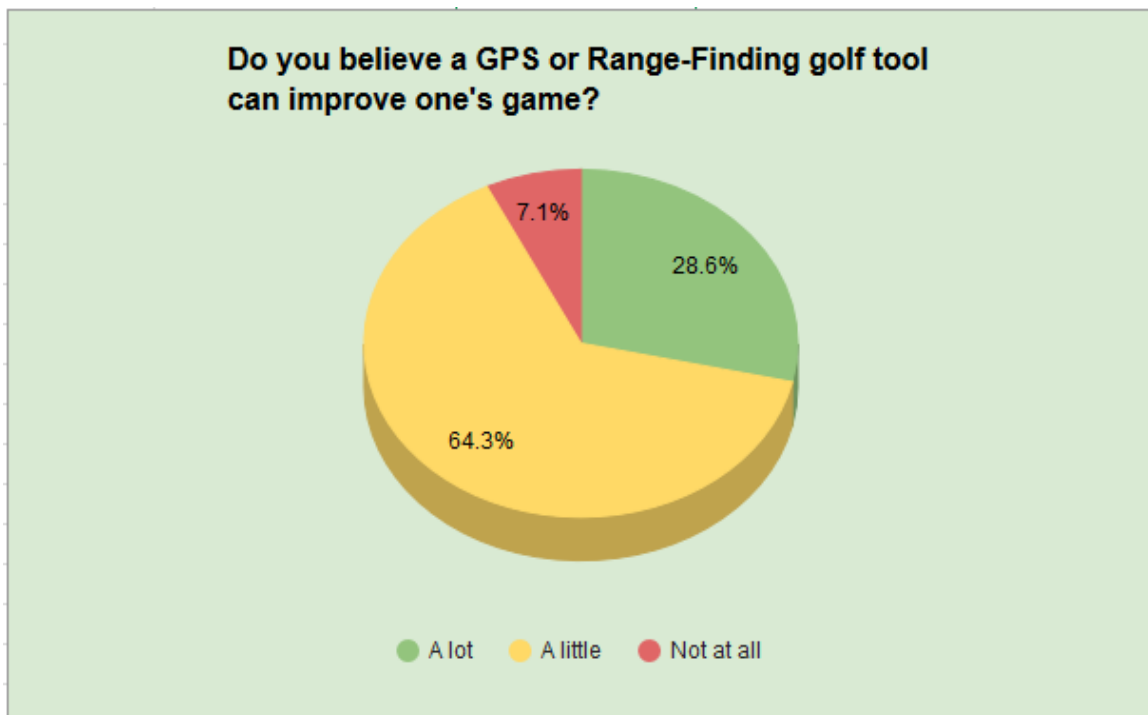

Figure 5. Survey Results – Do you believe distance measure devices are useful?

Personas

Utilizing the results from the Google questionnaire and to cover the broadest range of audience, three personas were conceived.

Persona One – Buddy Clarkson

BUDDY CLARKSON

"It speeds up the game, giving at least cursory information regarding distances to and from ball locations. Negates need to search for on course permanent markers."

From
Savannah, Georgia
Job
IT Project Manager (retired)
Age
74
Handicap
20

Buddy is a virtual lifelong golfer, picking the game up when he was a teenager. Ever since retiring from his position with the government, he has taken full advantage of the increased opportunities to get out on the course. He plays multiple times per week but especially enjoys when his son, Bernard, is able to join him.

Buddy has owned every type of distance measuring device that has been on the market. He and his golf buddies are always looking for advantages over one another and ability to speed up their round so they continue to try new devices. Buddy firmly believes these devices are a requirement to survive the conditions on the golf course.

Persona Two – Natalie Cruz

NATALIE CRUZ

"I'm mostly playing for recreation. If I ever played more seriously I would use a GPS."

From
New Haven, Connecticut
Job
Corporate Strategy Analyst
Age
27
Handicap
36

Last year, Natalie picked up the game of golf after she pretended to have interest for the sake of closing a business deal and ended up really enjoying the experience. The next weekend she was at her local golf store signing up for lessons. Though very busy with her work and travel schedule she tries to play at least once a month during the golf season.

Natalie has seen the many different types of distance measuring devices while shopping for supplies and apparel at golf retail stores. She knows their capabilities and while she is not committed to the game enough to buy one herself just yet, she frequently uses her friends' from time to time.

Persona Three – Jared Hall

JARED HALL

"I am a bit old school and like to manually determine the distance by using the course markers and by using the color of the flags to determine if I should add or subtract distance based on pin placement. I am not against GPS though."

Jared is one of the clubhouse professionals at the Towa Golf Course in Santa Fe. He has competed in a handful of PGA Tour events. He is a very skilled golfer who spends virtually every day on the course either playing or teaching classes for interested students of all skill levels.

Jared is very familiar with the latest technology designed to assist with play. While he agrees these devices can be a great help to some, he personally likes to rely on his own eyes and intuition. Professional golfers are not afforded the opportunity to use them, so he likes to simulate conditions he faces when competing in tournaments. However, he is hardly against them an often recommends his beginner to moderate skill level students to take advantage of their utility.

From
Santa Fe, New Mexico
Job
Clubhouse Pro
Age
41
Handicap
Scratch

Figure 6. Personas.

Chapter 4: Prototype

Prototype Tools

Advancing from the conceptualization steps and utilizing the sketches, process flow, and personas; a prototype could finally be drafted and tested. To arrive at the best prototype for testing and to allow for the smoothest transition to a testable product, it was decided to first mock up a paper prototype.

Standard-sized paper was used as a canvas for mechanical pencil drawn sketches. A phone was used to first roughly trace the outline for consistency in sizing. Other than that, the design was low-fidelity to communicate a sense of unfinished-ness and encourage testers to not withhold comments and suggestions. "People whose real interest is in solving the problem will always react better to a rough picture that shows the truth than a polished picture that makes no sense," (Roam, 2009). Once satisfied with the state of the paper prototype, expanding on the interactivity and transitioning these screens to a technical prototype commenced.

For the technical prototype, a desktop application called Balsamiq was utilized. Balsamiq is unique in that, while it provides the designer with a technical and clickable product, it also maintains the sketchy feel of how things might look drawn out with pencil and paper. Balsamiq does, however, provide the ability to inject color and import images to the design, slightly bridging the gap between a pure paper prototype and high fidelity technical prototype. The following two sections are screen captures from both the paper and technical prototype.

Prototype Design

Paper Prototype

The following are pictures of the designed paper prototype using pencil and paper from the conceptualization and initial user research.
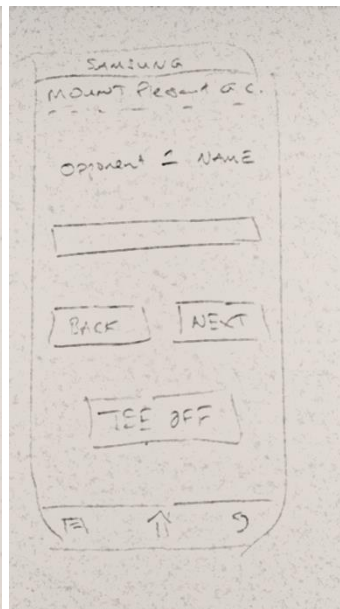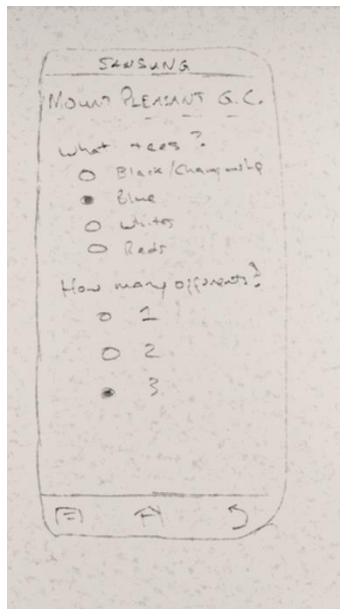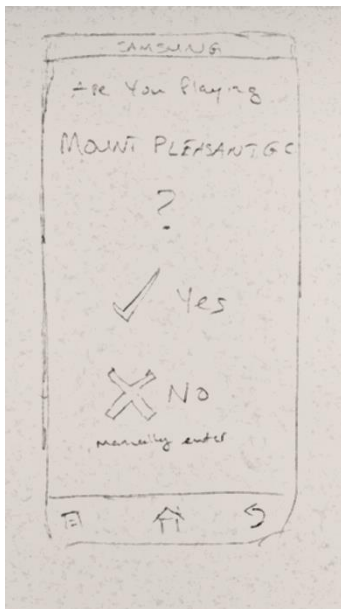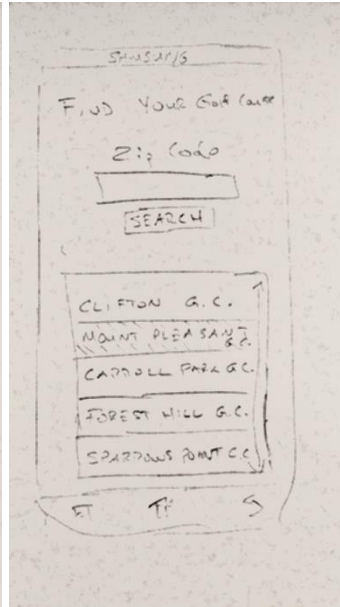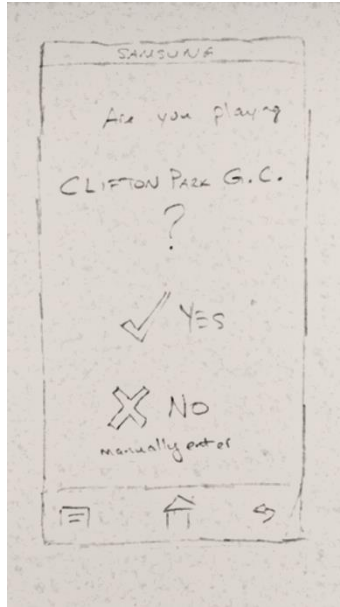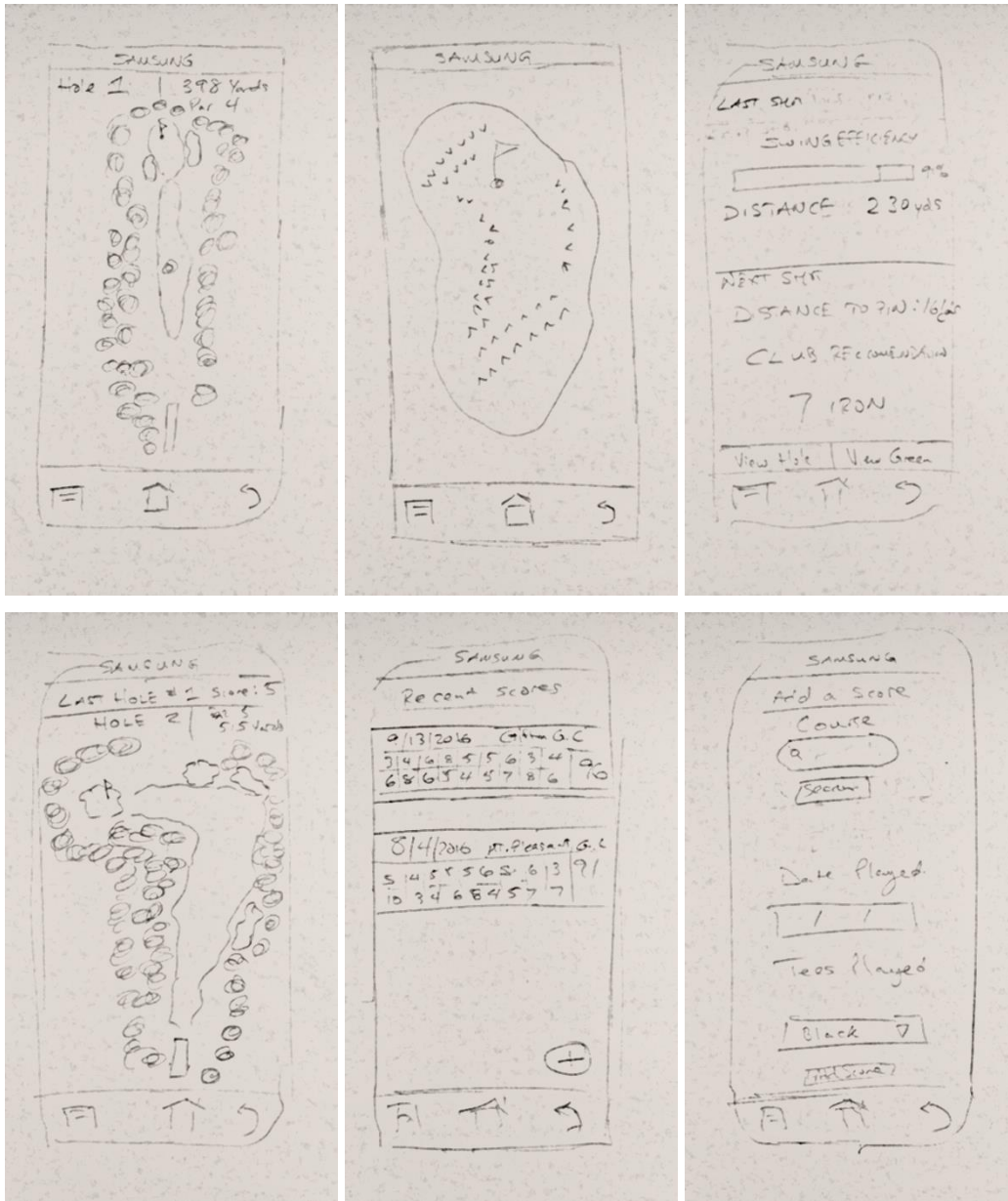
Figure 7. Paper prototype.

Technical Prototype

   The following are screenshots of the designed technical prototype using Balsamiq prior to testing.

CaddyGrips

Continue with Facebook

Continue with Email

CaddyGrips

Play a Round!

Scores

Are you playing...

CLIFTON PARK GOLF COURSE

✔ Yes

✖ No
(manually enter)

Back

Find your course by Zip Code

🔍 search

Search

Clifton Park Golf Course
Mount Pleasant Golf Course
Carroll Park Golf Course
Forest Hill Golf Course
Sparrows Point Golf Course
Mountain Branch Golf Club

More

Mount Pleasant Golf Course
Course Options

What tees?
○ Black (Championship)
◉ Blue
○ White
○ Red (Ladies)
○ Gold (Senior)

How many opponents?
○ One
○ Two
◉ Three

Back

Next

Mount Pleasant Golf Course

Opponent One Name

Back

Next

Figure 8. Technical prototype.

Prototype Testing

Methodology and Participants

      Participants for the technical prototype user research testing were recruited from the collection of participants in the distributed questionnaire. Each testing session lasted about 30 minutes and involved reviewing and signing the informed consent form (see Appendix B), presenting an overview of the prototype's purpose and vision, and allowing the participants to read and attempt to carry out each scenario. After finishing the testing, participants were asked for any additional questions or comments. To keep each testing session consistent, changes were not made to the prototype between each. This decision was made to allow for a greater amount of feedback before altering the original design.

      In accordance with the informed consent form and to protect the identity of the participants, each will be given and referred to by a code name. The first participant, Echo, is in the 66-75 age group having played the game for over 20 years. During his golfing season he plays about twice a week with a handicap of 20. The second participant, Kilo, is in the 26-35 age group and has played the game for 18 years. His handicap is 18 and plays about once a month during the golfing season. The final participant, Foxtrot, is also in the 26-35 age group having only picked up the game in the past 2 years. His handicap 36+ and only found time to play a handful of times ever. The participants selected covered a scope of varying ages, years played, and golfing skill which provided a range of feedback.

Scenarios

Testing the prototype involved five semi-sequential scenarios covering an overarching storyline of a person being introduced to CaddyGrips and going through a round of golf with it. Each participant was shown the first scenario and the amount of feedback determined if each subsequent scenario was covered.

      Scenario One. A friend just recommended a new "toy" to add to your golf game - CaddyGrips. After you take your set to the local golf shop to get the grips installed, you download the companion application to your phone. The day arrives you plan to use

CaddyGrips, set up your round of golf before teeing off. Task – Log into CaddyGrips using email address and set up round of golf at Mt Pleasant with three opponents.

Scenario Two. You arrive at the first tee of a round of golf. A daunting uphill 383 yard par 4 is your first challenge - it is the course's number 1 handicapped hole. You pull out your driver and take your best swing. The swing feels great and you watch the ball soar unfortunately toward the fairway bunker (see Appendix C for golf terminology). You land short of it but end up rolling in. Check your phone to see just how good your swing was and take note of the wind you forgot to account for. When you arrive at your ball see just how far you hit. Task – Check swing feedback and how you may have mishit.

Scenario Three. You arrive at your ball in the bunker and see the 150 yard marker a few steps ahead of you in the fairway. You check your phone to see the exact distance and the applications recommendation considering your lie in the bunker, the remaining uphill distance, and the quality of your last swing. Use the app to access an overhead view of the green to get a better idea of where to aim. Task – Check the elevation of the hole's green so you know where to aim.

Scenario Four. Later in the round, on the 15th hole you find yourself in the middle of the fairway of the reachable in two par 5 after an excellent round. You have been swinging well and the application recommends you go for the green rather than laying up. Use the application to check wind, green view and get a club recommendation. Task – Check the green view and club recommendation.

Scenario Five. After one of your best rounds of the season you arrive home to review your score. You decide the application is one you want to stick with and grab some old score sheets to enter into the program's database. Task – Check to make sure the application saved your score. Add notes for how you did. Then add a previous round of golf.

Prototype Results

Feedback

Participant Echo, had the most experience with GPS devices, having owned several different types and models. He shared that he is currently is using the Garmin S6 GPS watch. He did not have trouble completing any of the tasks. From the first scenario, he suggested that the verbiage of "opponents" should be switched to "playing partner" as he noted, "many golfers don't look at the people they play with as opponents, but rather the course itself so using 'opponent' doesn't always apply." From the second scenario he was at first a bit confused by the abbreviation of "Eff" for efficiency and later noted that he felt it was probably not necessary as it could be too complicated. From the third scenario, he felt that distance to pin should be either substituted or complemented with distance to front and back of the green to help with selecting clubs. He also brought up the importance of what type of lie the ball is in and if an obstacle was potentially hindering the next shot.

At the end of the testing Echo suggested that the last shot and next shot information be split up rather than being on one screen. This would create more space for each and allow for more information to be presented to the player like the aforementioned distances to front, middle, and back of green and wind conditions.

Participant Kilo presented great feedback as well. He did not have much trouble completing the tasks with similar comments to Echo in certain areas. He agreed that the last shot and next shot information probably shouldn't be on the same screen. However, he thought that the next shot information would be better integrated with the overhead view of the hole which would also provide shot path graphics to better plan a strategy. Additionally, in accordance with declaring what type of lie and conditions for the next shot, a full vs half swing should be able to be calculated. Also, interestingly, he assumed "Eff" stood for effort rather than efficiency.

Kilo also provided great suggestions to be added to the design of the prototype. To tap into the emotions of the player, he suggested that the application recognize good shots and good rounds of golf while also allowing the player to make note of these

manually. Another feature to keep pace with the ever step-conscious world would be to calculate the number of steps and distance walked in each round. This would help promote further play as players typically walk a few miles if they don't opt to use a golf cart. Finally, Kilo asked if the application would have a visual caddy character to provide shot selections and feedback.

Participant Foxtrot, despite being the last tested, provided a myriad of unique and constructive feedback. With an engineering background, after hearing the description of the solution and before attempting each of the scenarios, he questioned how the grips themselves would be powered and how they would communicate with the application. Like Echo and Kilo, Foxtrot had questions about the algorithm that decided the efficiency rating.

He had further suggestions for the last shot screen. He suggested that the swing arc be visually represented within the last shot feedback and suggested that this and the point of contact representation could be color coded with green being a good location/arc, yellow being average, and red being poor. Additionally, he thought showing where the person was holding the club would be important. This could be achieved with pressure or heat signatures. For the next shot recommendation, Foxtrot thought letting the player know when they should hit a draw, fade, or apply backspin would be beneficial as well.

Design Evolution

While there was a ton of great feedback, it was decided that the application screens revolving around the view of the hole and the last shot and next shot recommendation should be improved. These are the heart of the application and further designing them would best make a case for the validity of the prototype.

At the forefront of priorities was the ability to easily switch between the map view and the last shot's information. This was an issue encountered by each participant which required additional explanations. Improving upon the layout and positioning of key information along with providing a few more pieces of data was also taken into account. To more readily see the design changes, the before screens will be shown again followed

by the three screens which encompass the majority of screens driven by the user research an annotated.

(Previous) Hole View and Shot Caddy Screens

The hole's information was provided on the Hole View screen but would need to switch between this view and the shot caddy screen to see recommendations. Also lacked more information on the shot and did not take into account lie or other obstacles potentially hindering a full swing (see Appendix C for golf terminology) each time.
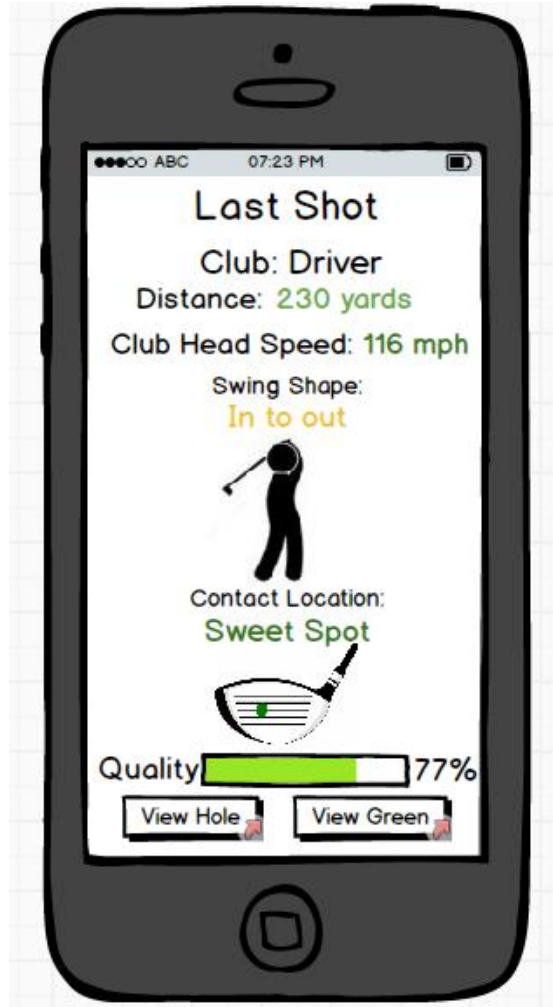
Last Shot Screen

This screen will now give more visual feedback with easily identifiable color coded data. Green will be good, yellow will be acceptable, red will be poor. The distance the ball traveled, club head speed, swing shape, and point of contact will all be factored into the overal quality of swing. Buttons to access next shot/hole view, and green view have been added to easily switch between screens. (See Appendix C for golf terminology.)

(Not picture) Clicking into the swing shape or club head will provide greater detailed feedback and offer suggestions, when applicable.

Next Shot / View Hole Screen

A customizeable caddy avatar has been added to the top of the screen to give a more personal connection to the advice given. The caddy will now provide the club selection as well as the type of swing he suggests. Below this will be an ability to manual correct or notify the application of the lie or of a particular obstacle that may be obstructing the shot. This will cause the caddy to suggest other types of shots. The screen also provides temperature and wind conditions along with distances to front and back of green and, when applicable, specific landmarks or hazards on the hole. At the bottom there will be buttons to acces the last shot information or green view. At the top the applciation will track overall round score with the score of the current hole.

View Green Screen

This screen will be almost identical to the View Hole Screen. The caddy, score, temperature, wind, directional and hole information will display the exact same. The difference will be that the caddy will give the overall read and condition of the green. Not visually represented in the above screenshot, the picture will better show slopes and breaks in the green so that the player will have a "second pair of eyes" when making reads for the putt. The bottom buttons will link to the last shot feedback and the overall hole view.

Figure 9. Updates to technical prototype (first round).

Another Round of Testing

An additional, more focused, round of interviewing was conducted afterwards on the following revised screens from the previous round of testing – the last shot screen, the view hole screen, and the view green screen. Because these screens are the focal point of the designed concept, executing a round of testing specifically for them felt appropriate to maximize the quality of feedback. These testers came from the same pool of questionnaire respondents and were given a short description of the application for proper context. The testers were encouraged to give candid feedback with open ended questions such as "does everything make sense; if not what does not?", "is there too much information?", "is there too little information; can you think of any details missing?", and "does the layout make sense to you?" While they enjoyed the concept, each offered constructive criticism and beneficial feedback on how the application could be better developed.

The first participant of this round, given the name Gamma, is between the ages of 26 and 35, has played golf for about 15 years, has a handicap between 11 and 15, and plays multiple times per month. Gamma believed this concept could be expanded further into an instructional app outside of live play and more so for practicing at the driving range. Additionally, more from a marketing point of view, he thought the instructional additional could lead to in-app purchases and also thought partnering with companies that specialize in grips would be beneficial to the products potential. He named a two companies in the grip industry – Golf Pride and Winn.

As for the screens, Gamma thought the post-shot screen was great and had no feedback. The pre-shot screens induced the most comments. He wanted the graphics of the hole and green to be larger while also believing that the metrics of temperature, true North direction, and even the caddy avatar were extraneous. He suggested to remove the first two completely and adjust the app to only have the caddy appear when requesting help. His final suggestion was the further expand on the types of recommended shots, "i.e. full 7 iron or 5 iron punch shot." (See Appendix C for golf terminology.) Gamma

finished the interview stating that "Perhaps I'm thinking in the vain of golf video games, but that interface make so much sense to me."

The second participant, who will be called Lambda, is also in the age range of 26 to 35 but is newer to the game of golf having only started in the last couple of years. His handicap is 36+ and he only has played a handful of times. Lambda echoed the sentiments of Gamma about the potential to have this application's instructional potential. "I'd consider including a practice element at a driving range or something where you hit a few balls with each club so the app can learn about a golfer's swing and tailor recommendations when on a real course," he stated.

Lambda offered layout specific suggestions. Some key tweaks he suggested were to make the "Last Shot" better stand out on the screen, move the hole information (number, par, and yardage) from the bottom of the screen to the top, and a better way to distinguish the round's score vs the current hole's score. He also suggested expanding the putting recommendations to include a rough estimation for power and where to aim. Though, not depicted on any of the screens, he suggested a congratulatory message for especially good scores once the golfer indicates they are finished with a hole. (This is a manual process to avoid locational errors on the possibility that a shot carries onto the territory of another hole.)

Alpha was the coded name given to the third participant. In the 26 to 35 age range, she has played the game off and on for about a decade and has a handicap above 36. Alpha's feedback was mostly positive but had some uncertainty on some of the metrics offered. She was unsure of other possible results for the club head location other than the "sweet spot" included in the image. Alpha's biggest criticism of the application was the amount of screen space the caddy avatar occupied and suggested that he be removed completely from the screen and only appear on the main screen of the application.

The fourth participant was given the moniker Epsilon. He is between the ages of 46 and 55 has played golf on and off for over a decade and has a handicap between 31 and 35. His initial feedback touched on the application's potential, "if all the tech issues

could be worked out, this could be a game changer for intermediate to season players."
Like Gamma and Lambda, he touched on the application's potential for instruction, as
well. He also suggested including a rule book to be accessed as golf has some rules that
are not visceral. In light of this, Epsilon proposed adding a menu to the layout for better
navigation to the settings.

The following screens are a consolidation of the feedback given from the last
round of testing. For better comparison each screen is preceded by the previous version
from the earlier round of testing.

Last Shot Screen

This screen has adjusted the layout and order of information. Ever present at the top across all screens will be the score and current hole information. It also has a menu to access tutorials, rules, and the main menu screen. The last shot metric bar can be found at the top followed by the shot animtion and ball contact point. Clicking each will provide a little more detail. The rest of the screen has all the information about the shot oriented in a simple table view color coded in the normal green – good, yellow – okay, red – bad scheme. Added to the information provided is ball path to indicate whether you hit a straight shot, or a draw or fade.

Next Shot / View Hole Screen

This screen also has moved the hole and score information at the top along with a menu to quickly access rules, tutorials or the main screen. The graphic size is significantly larger to take advantage of the screen's real estate. The golf caddy avatar has been removed alotgether and the advice has been changed to display with opacity on top of the hole's graphic. This information can be toggled on and off with an information icon found at the upper right of the hole. The adjust lie function has been moved to the bottom of the screen to make it easer to change with a thumb. Temperature, wind, and directional information has been removed completely.

View Green Screen

This screen incorporates many of the same changes as the view hole screen. It has removed temperature, wind, and directional cues. It has increased the graphic size and removed the caddy avatar. It also has included the caddy's advice, toggleable by the information icon, overtop of the graphic.

Figure 10. Updates to technical prototype (second round).

Chapter 5: Final Remarks

Project Limitations

   This project faced limitation in resources. Sample size in every phase of user research could be expanded for a greater number of feedback. Besides just sheer number of respondents not being ideal, the diversity of the respondents should be taken into consideration. While the diversity of age was dominated by 26 to 35 and 56 to 65 age groups, feedback from other age groups could be increased. The Mid-Atlantic region of the United States was over represented in the user research phase. Interviewing and testing participants from other areas around the country and world may yield differing views on some of the questions asked and how the game of golf is perceived in general. Finally the skill level/handicap of the participants surveyed was disproportionately of lower skill levels. As this application's function would be better suited toward intermediate to higher skill level users, it would be beneficial to have surveyed more skillful golfers.

   Beyond user research demographic limitations, the fidelity of the prototype was a limitation. Often questions were asked on what something was meant to do or how it was meant to function. Ideally, a prototype would have been constructed to operate in a way that would limit these types of questions so that the participant can focus on its intuitive and efficacy. With additional resources a working prototype would be developed to be test during an actual round of golf to better identify potential design flaws via replicating scenarios more efficiently. This would also allow the physical grip aspect of this concept to be tested in tandem with the technical side.

Moving Forward

   To take this concept and prototype to the next step would require more laborious user research. Further user testing on the prototype in tandem with a prototype design to represent the tangible grip part of the solution would give a greater idea as to the usefulness and application of the ideas together. Down the line, a working prototype

would need to be developed to be used in more consciously constructed scenarios to make sure that the scope of features included would be fruitful.

　　　　After rounds of testing and as the prototype got closer to a vision to be released to the public, cosmetic decisions would need to be made. Typefaces, colors, logos and other graphics would need to be decided upon along with final decision on how the grips themselves would be created. Once finalized, a marketing and operations plan would need to be established.

Designer Information

　　　　The designer of the prototype and author of this paper is Julian Christopher Andrews. This paper marks the conclusion of his Masters of Interaction Design and Information Architecture at the University of Baltimore in Baltimore, MD. He can be reached at email address - prime21@gmail.com or mailing address – 8560 Castlemill Circle, Nottingham, MD 21236.

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Appendix A: Google Questionnaire Raw Data Results

Timestamp	How often do you golf per year?	What is your age group?	Have you played a round of golf (9 holes or more) at least once in your life?	What is your handicap?	Do you play public and private courses?	Do you use/Have you used a GPS or Range-Finding golf tool?	Why or why not?	If you have used a GPS or Range-Finding golf tool, what type have you used?	Do you believe a GPS or Range-Finding golf tool can improve one's game?
7/22/2016 12:40:19	1 - 5 times per year	36-45	Yes	36+	No, I play public courses exclusively	No, never.	That would involve me spending more money and being more serious than I'd like to be.		Not at all
7/22/2016 15:13:28	Multiple times per week	56-65	Yes	21-25	Yes, but I play public courses more frequently than private	Yes, I own at least one.	It eliminates guessing	Watch	A lot
7/22/2016 16:41:32	Weekly	56-65	Yes	21-25	Yes, but I play public courses more frequently than private	Yes, I own at least one.	I like techie things.	Watch	A little
7/22/2016 17:49:05	Multiple times per week	66-75	Yes	16-20	Yes, but I play public courses more frequently than private	Yes, I own at least one.	It speeds up the game, giving at least cursory information regarding distances to and from ball locations. Negates need to search for on course permanent markers.	View finder, Handheld, Watch	A little
7/22/2016 17:54:31	Weekly	56-65	Yes	26-30	No, I play public courses exclusively	Yes, I own at least one.	I find the information provided by the GPS to be very helpful in club selection.	Watch	A little
7/22/2016 18:19:05	Multiple times per week	26-35	Yes	1-5	Yes, but I play public courses more frequently than private	Yes, I own at least one.	I have a bushnell laser rangefinder. It gives me immediate exact distances to anything I point it at. I can't play without it anymore.	Handheld, GPS app on phone	A lot
7/23/2016 10:22:34	1 - 5 times per year	56-65	Yes	26-30	Yes, but I play public courses more frequently than private	Yes, I've used a friend's.	Better results.	Handheld	A lot
7/23/2016 12:48:25	1 - 5 times per year	26-35	Yes	1-5	Yes, but I play private courses more frequently than public	No, never.	I am a bit old school and like to manually determine the distance by using the course markers and by using the color of the flags to determine if i should add or subtract distance based on pin placement. I am not against gps though. At some courses the carts are equipped with the technology and that is a convenient functionality.	Cart equipped	A little
7/23/2016 13:33:33	1 - 5 times per year	26-35	Yes	Don't Know	Yes, but I play public courses more frequently than private	No, never.	I am not good enough to know which club I should use at each distance		A little
7/23/2016 13:49:09	1 - 5 times per year	26-35	Yes	36+	Yes, but I play public courses more frequently than private	No, never.	I'm mostly playing for recreation. If I ever played more seriously I would use a GPS.		A lot
7/23/2016 13:55:32	Monthly - BiWeekly	26-35	Yes	21-25	Yes, but I play public courses more frequently than private	Yes, I've used a friend's.	Find out distance	Handheld	A lot
7/23/2016 19:28:41	Weekly	56-65	Yes	21-25	No, I play public courses exclusively	Yes, I own at least one.	To aid in proper club selection.	Handheld	A little
7/23/2016 22:17:08	1 - 5 times per year	36-45	Yes	21-25	Yes, but I play public courses more frequently than private	Yes, I've used a friend's.	Use it in an attempt to select a suitable club for the next shot.	Handheld	A little
7/23/2016 22:18:44	Weekly	56-65	Yes	6-10	Yes, but I play public courses more frequently than private	Yes, I own at least one.	To verify yardage	View finder, Handheld, Watch	A little
7/23/2016 22:29:21	Monthly - BiWeekly	36-45	Yes	36+	No, I play public courses exclusively	Yes, I own at least one.	For better accuracy on distance to aid in club/shot selection	View finder, Handheld, cell phone app	A little
7/24/2016 10:34:41	Monthly - BiWeekly	26-35	Yes	21-25	Yes, but I play public courses more frequently than private	No, never.	Expensive		A lot
7/25/2016 20:09:03	Weekly	26-35	Yes	21-25	Yes, but I play public courses more frequently than private	No, never.	Never heard of it		A little
7/26/2016 8:49:06	Monthly - BiWeekly	26-35	Yes	16-20	No, I play public courses exclusively	Yes, I've used a friend's.	Just wanted to see what it was all about.	Handheld	Not at all
7/27/2016 20:07:03	1 - 5 times per year	46-55	Yes	26-30	Yes, but I play private courses more frequently than public	No, never.	I don't play often enough to use one.		A little
7/27/2016 20:18:25	Monthly - BiWeekly	46-55	Yes	11-15	Yes, but I play public courses more frequently than private	Yes, I've used a friend's.	Don't really need one...do a good job of knowing my distances	Handheld, Watch	A little
7/27/2016 21:04:34	1 - 5 times per year	56-65	Yes	26-30	Yes, but I play public courses more frequently than private	Yes, I've used a friend's.	I don't play enough to feel that it is useful.	View finder, Handheld, Watch	A little
7/27/2016 21:14:50	Monthly - BiWeekly	26-35	Yes	16-20	Yes, but I play public courses more frequently than private	No, never.	I like to rely on feel rather than a tool. More so, I have played with people who use range finders and I guess within 1 or 2 yards every time.		A little
7/28/2016 0:13:25	Multiple times per week	56-65	Yes	21-25	Yes, but I play public courses more frequently than private	Yes, I own at least one.	helps with club selection	Handheld, Watch	A lot
7/28/2016 3:52:53	Weekly	26-35	Yes	11-15	No, I play public courses exclusively	Yes, I've used a friend's.	They are very expensive. Seem cumbersome.	View finder	A little

Timestamp	How often do you golf per year?	What is your age group?	Have you played a round of golf (9 holes or more) at least once in your life?	What is your handicap?	Do you play public and private courses?	Do you use/Have you used a GPS or Range-Finding golf tool?	Why or why not?	If you have used a GPS or Range-Finding golf tool, what type have you used?	Do you believe a GPS or Range-Finding golf tool can improve one's game?
7/28/2016 5:42:24	1 - 5 times per year	36-45	Yes	Don't Know	No, I play public courses exclusively	Yes, I've used a friend's.	to get accurate distances	View finder, cell phone	A lot
7/28/2016 9:58:47	Weekly	56-65	Yes	Don't Know	Yes, but I play public courses more frequently than private	Yes, I own at least one.	Helps me decide which club to use for distance.	Handheld	A little
7/28/2016 17:28:08	Weekly	56-65	Yes	21-25	Yes, but I play public courses more frequently than private	Yes, I've used a friend's.	It helps with club selection	Watch	A little
8/7/2016 13:14:13	Weekly	46-55	Yes	26-30	Yes, but I play public cour	Yes, I own at least one.	Helps gauge distance	app on smartphone	A little

Appendix B: Informed Consent Form

Informed Consent

TITLE OF STUDY
Design of golf GPS prototype

PRINCIPAL INVESTIGATOR
Julian Andrews
Interaction Design and Information Architecture
8560 Castlemill Circle, Nottingham, MD 21236
609-238-9606
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PURPOSE OF STUDY

You are being asked to take part in a research study. Before you decide to participate in this study, it is important that you understand why the research is being done and what it will involve. Please read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information.

The purpose of this study is to measure the effectiveness of a prototype designed to aid in golfing via global positioning software. The study will also determine the effectiveness and versatility of the user interface designed within the prototype's application.

STUDY PROCEDURES

Study investigator will explain purpose of study and review consent form – 3 mins
Investigator will introduce prototype – 1 mins
Investigator will explain each scenario and observe participant's actions – 3 mins each
Investigator will thank participant and allow for questions or comments – 3 mins

RISKS

You may decline to answer any or all questions and you may terminate your involvement at any time if you choose.

BENEFITS

There will be no direct benefit to you for your participation in this study. However, we hope that the information obtained from this study may lead to a great appreciation for the effectiveness of using global positioning software devices to assist in golf game.

Page 1 of 3

Participant's Initials: _____

Informed Consent

CONFIDENTIALITY

Your responses will be anonymous. Please do not write any identifying information.
Every effort will be made by the researcher to preserve your confidentiality including the
following:

- Assigning code names/numbers for participants that will be used on all research
  notes and documents
- Keeping notes, interview transcriptions, and any other identifying participant
  information in a locked file cabinet in the personal possession of the researcher.

Participant data will be kept confidential except in cases where the researcher is legally
obligated to report specific incidents. These incidents include, but may not be limited to,
incidents of abuse and suicide risk.

CONTACT INFORMATION

If you have questions at any time about this study, or you experience adverse effects as
the result of participating in this study, you may contact the researcher whose contact
information is provided on the first page. If you have questions regarding your rights as a
research participant, or if problems arise which you do not feel you can discuss with the
Primary Investigator, please contact the Institutional Review Board at (865) 354-3000,
ext. 4822.

VOLUNTARY PARTICIPATION

Your participation in this study is voluntary. It is up to you to decide whether or not to
take part in this study. If you decide to take part in this study, you will be asked to sign a
consent form. After you sign the consent form, you are still free to withdraw at any time
and without giving a reason. Withdrawing from this study will not affect the relationship
you have, if any, with the researcher. If you withdraw from the study before data
collection is completed, your data will be returned to you or destroyed.

Page 2 of 3

Participant's Initials: _____

Informed Consent

_____

CONSENT

I have read and I understand the provided information and have had the opportunity to ask questions. I understand that I will be given a copy of this consent form. I understand that my participation in this study may involve audio/visual recording. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Participant's signature _____

Participant's printed name _____

Date _____

Investigator's signature _____

Investigator's printed name _____

Date _____

Participant's Initials: _____

Appendix C: Golf Terminology

The following terms are used throughout the paper.
- Clubs
    - Woods – Clubs numbered 1 to 5, usually odd numbered, with the largest club head and used to hit the ball the longest distance, often off the tee.
    - Irons – Clubs numbered 1 to 9. Used for mid-range shots.
    - Hybrids – Clubs utilizing features of both irons and woods used for mid-range shots, like irons. They are, however, more forgiving than irons.
    - Wedges – Clubs denoted with letters used for short-range shots around the putting green. Pitching, Sand, Lob and Gap wedges are common wedges.
    - Putter – Club used specifically for the putting green and getting the ball into the hole.
  (GolfSmith, 2016)

- Golf Lies – where the ball can come to rest and potentially be played from
    - Tee Box – Starting point of each hole. Players typically use a tee to elevate the ball before aiming for the Fairway or Putting Green, dependent upon the par of the hole. Courses have color coded Tee Markers to indicate the starting distance to determine a course's difficulty level. The standard color order from furthest and most difficult to closest and least difficult is Black (Championship distance), Blue, White (Men's distance), Red (Women's distance), Green (Senior distance), and Gold/Yellow
    - Fairway – Low cut grass which makes it way from the Tee Box to the Putting Green. It is the ideal landing area before aiming for the Putting Green.
    - Putting Green – A designed patch of low cut grass where golfers putt towards a hole.
    - Fringe – Grass adjacent to the Putting Green with slightly higher cut of grass. It separates the Putting Green from the Rough or Fairway.
    - Rough – A higher cut of grass than the Fairway more resembling a natural length. Because of its higher cut, golfers prefer to land in the Fairway as opposed to this area. Even higher grass can be called Deep Rough.
    - Sand/Bunker Hazards – A hazard consisting of sand typically placed in areas to make a hole more difficult as they are a challenge to successfully exit.
    - Water Hazards – A natural or manmade body of water making the hole more difficult. In most cases, when a ball lands in the water, a one stroke penalty is issued and a new ball is dropped in a designated area to resume play.
    - Out of Bounds – An area on a hole deemed to be illegal to play from. This area can be a water hazard, a heavily wooded or unsafe area. The area can

be marked by short white stakes along the border. A one stroke penalty is
issued and a ball is dropped at the entry point when landing in this area.
(TheMatchPlayer.com, 2016)

- Handicap – A numerical representation of a golfer's playing ability. The lower a
golfer's handicap, the better the golfer is" (Kelley, 2016). An index used to level
the playing field for golfers of different skill levels. It is calculated by taking a
player's score and subtracting (Gregory, 2009). Handicap is the average net score
to par of a course, or the total strokes needed to finish the course. Each hole has a
specific par. If the handicap of a player is at or below 0, they are considered a
"scratch golfer" (Kelley, 2016).

- Scoring Terms
  o Bogey – A score one above par. (Double bogey is two above, Triple bogey
  is three above, etc.)
  o Par -The score an accomplished player is expected to make on a hole,
  either a three, four or five.
  o Birdie – A score one below par.
  o Eagle – A score two below par.
  o Albatross – A score three under par. Also called a Double Eagle. (only
  possible on a par 4 or 5)
(Laird, 2016; PGA.com, 2003)

- Shot Type
  o Full Swing – A traditional shot where the golf uses a full swing to
  maximize the selected clubs distance.
  o Punch – A low trajectory shot executed with a Wood or long Iron to better
  maintain control of the ball and avoid obstacles such as tree branches. It is
  executed with a half back swing and half follow thru.
  o Chip – A close-range low arching shot used around the Putting Green
  typically executed by a Wedge to take advantage of the roll of the golf ball
  once on the ground.
  o Pitch – A close-range high arching shot used around the Putting Green
  typically executed by a Pitching, Gap, or Lob Wedge to limit the roll of
  the ball once it lands.
  o Putt – A shot executed by the Putter on the Putting Surface where the ball
  maintains contact with the ground as it is hit towards the golf hole.
(TheMatchPlayer.com, 2016)

Appendix D: Google Questionnaire

Global Positioning System and Range-Finding Tools Used In Golf

This questionnaire is designed to aid in the research of the trends and frequency of use of golf performance aiding tools and technology. If you are not 18 years or older or have not played at least 1 round of golf (minimum 9 holes) you do not qualify for this research study. Thank you.

What is your age group?

If you answer less than or equal to 17, please exit the survey.

- ○ Less than or equal to 17
- ○ 18-25
- ○ 26-35
- ○ 36-45
- ○ 46-55
- ○ 56-65
- ○ 66-75
- ○ More than or equal to 76

Have you played a round of golf (9 holes or more) at least once in your ⬍

If you answer no, please exit the survey.

- ○ Yes
- ○ No

How often do you golf per year? *

○ 1 - 5 times per year

○ Monthly - BiWeekly

○ Weekly

○ Multiple times per week

What is your handicap?

What is your typical score per 18 holes in relation to par?

○ Scratch

○ 1-5

○ 6-10

○ 11-15

○ 16-20

○ 21-25

○ 26-30

○ 31-35

○ 36+

○ Don't Know

Do you play public and private courses?

○ Yes, but I play public courses more frequently than private

○ Yes, but I play private courses more frequently than public

○ No, I play public courses exclusively

○ No, I play private courses exclusively

Do you use/Have you used a GPS or Range-Finding golf *

○ Yes, I own at least one.

○ Yes, I've used a friend's.

○ No, never.

Why or why not? *

Long answer text

If you have used a GPS or Range-Finding golf tool, what type have you

Select all that you have used

☐ View finder

☐ Handheld

☐ Watch

☐ Other...

Do you believe a GPS or Range-Finding golf tool can improve one's *

○ Not at all

○ A little

○ A lot