Golf ball mark repair tool

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BALL MARK REPAIR TOOL

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Abstract

Something every golfer must deal with is fixing a ball mark that was left by their shot onto the green. The conventional way to fix a ball mark involves bending over for an extended period of time that causes stress on the back, hips, and knees of the player. A product was designed to keep the golfer from bending over while still allowing them to properly fix their ball mark to maintain proper course conditions. The tool functions by attaching to the grip of the putter and uses a cone design to push the lifted grass towards the center of the ball mark. The product was found to be 80% effective at fixing a ball mark and also avoided lasting green damage that can occur while fixing a ball mark the conventional way.

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1. Introduction

Golf is an extremely popular sport in the United States and is still continuing to grow. There are roughly 24.3 million golfers in the US alone with the average age of those golfers being 54. A problem that every golf player faces numerous times in a round is having to fix their ball mark on the green. A ball mark is a small crater left on the putting surface caused by the player's ball landing on the green at a high speed. If not fixed correctly, a ball mark can cause lasting damage to the green and also interfere with another player who putts their ball over the unfixed mark. The conventional way to fix a ball mark requires the golfer to bend over for a period of time to use a two-pronged ball mark fork to push the grass and dirt back to the center of the mark before flattening the surface with their foot or putter. Because of the bending motion, stress is put on the back, hips, and knees of the player. The goal of the new ball mark repair tool is to avoid the bending motion while still allowing the player to properly fix their ball mark. Data was collected on ball mark size which could be incorporated in the design. Going into the design, it was decided that the tool should be small and lightweight for convenience and be able to attach to the putter grip in order to keep the golfer from bending over. This tool will help older golfers as well as younger players who struggle to fix their own ball mark.

2. Design

The main goal of the design is to help golfers avoid bending over to fix their ball mark. Secondary goals are to fix the ball mark properly and keep the tool small and convenient for the golfer to use. The size of the tool must remain small due to the fact that most golfers don't want to add additional objects to the club section of their golf bag. A small size will allow the golfer to keep the tool in a zipper pocket of their bag or in their golf cart for easy access when going to the green to fix their ball mark. In order to keep the small size and still prevent the golfer from bending over, the tool will be able to attach to the grip of the putter. According to the USGA, normal putter grip size is 1 inch with the max diameter being 1.75 inches.

In order to get create the proper sized tool, data was collected on various ball marks. The data was collected at numerous golf courses to represent different types of grass used on a green as well as different weather conditions.

Ground Moisture	Temperature	Ground Hardness	Divot Depth	Divot Width	Divot Length
Slightly Damp	61 F	Moderate	0.5	1.769	3
Slightly Damp	63 F	Moderate	0.4	0.75	1.16
Slightly Damp	63 F	Moderate	0.4	0.89	1.52
Slightly Damp	63 F	Moderate	0.75	1.2	1.67
Slightly Damp	65 F	Moderate	0.5	1.07	1.33

Slightly Damp	65 F	Moderate	0.4	0.948	1.654
Slightly Damp	65 F	Moderate	0.5	1.279	1.93
Slightly Damp	65 F	Moderate	0.9	1.49	1.665
Slightly Damp	65 F	Moderate	0.2	1.125	1.385
Slightly Damp	65 F	Moderate	0.45	1.1805	1.315
Slightly Damp	65 F	Moderate	0.5	1.2295	1.4105
Slightly Damp	65 F	Moderate	0.2	1.083	1.362
Slightly Damp	65 F	Moderate	0.7	1.225	1.346
Slightly Damp	74 F	Moderate	0.7	1.2695	1.692
Slightly Damp	75 F	Moderate	0.4	1.1575	1.35
Slightly Damp	75 F	Moderate	0.3	1.0875	1.9685
Slightly Damp	75 F	Moderate	0.3	1.226	1.42
Slightly Damp	75 F	Moderate	0.4	1.302	1.382
Slightly Damp	75 F	Moderate	0.45	1.0045	1.23
Slightly Damp	75 F	Moderate	0.35	1	1.4945

Wet	76 F	Soft	0.625	1.125	2.75
Wet	77 F	Soft	0.5	1	1.5
Slightly Damp	78 F	Soft	0.25	1.25	2.375
dry	86 F	Hard	0.375	1.1	0.875
dry	87 F	Hard	0.25	1.25	1.5
dry	88 F	Hard	0.375	1.125	2
dry	89 F	Hard	0.56	0.875	2.125
dry	90 F	Hard	0.325	1.125	1.375
dry	91 F	Hard	0.25	1	1

Table 1 Data collected on the golf course for the dimensions of a ball mark in various green conditions

2.1 Procedure

The original plan for the design was to create a tool that would simulate the conventional way to fix a ball mark. The conventional method consists of the golfer inserting a two-pronged fork into the grass on the outer perimeter of the ball mark and slightly lifting the fork. This motion is repeated numerous times around the mark in order to draw the lifted grass and dirt surrounding the indentation back to the center. When this process is completed, the golfer then uses either their putter or foot to flatten the grass back to its original condition.

To begin the design process, a weighted decision matrix was created to decide which parts of the design would be most important.

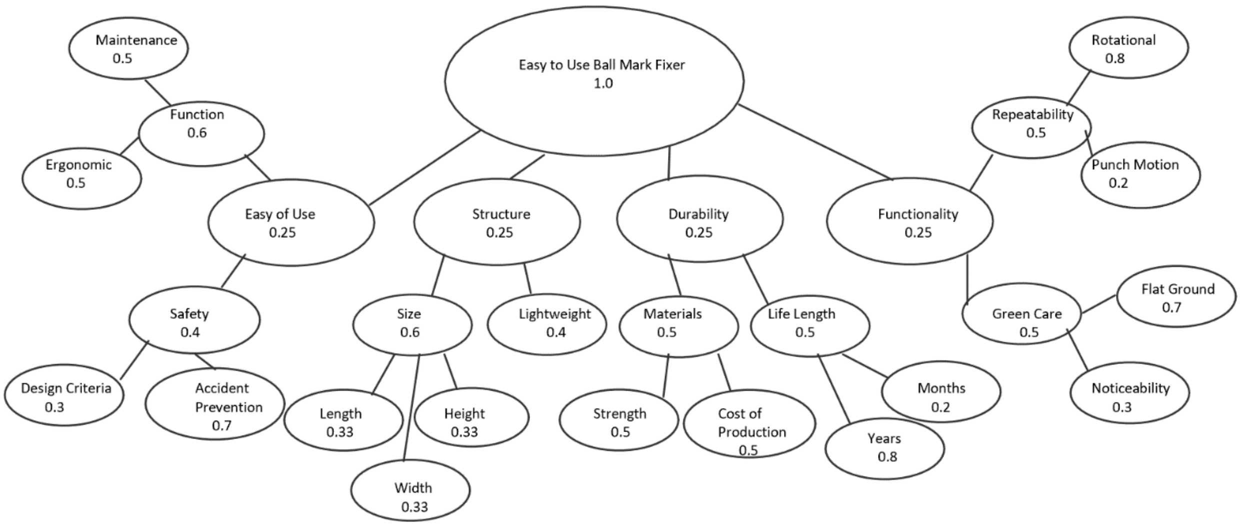

Figure 1 Weighted Decision Matrix

The weighted decision matrix was used as a guide during the brainstorming phase to decide which parts of the tool would be most important. At the end of the brainstorming phase, three main ideas emerged. The first idea was a retractable stick with a fork similar to the current ball mark repair tool at the end of it. When this design was further researched, concerns arose about the durability and size of the design. It was decided that if this tool was

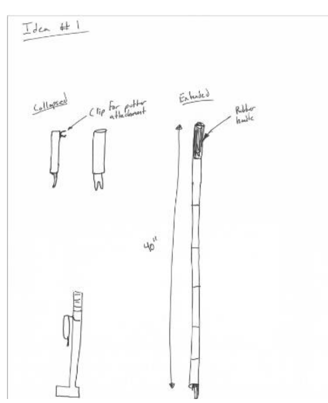

Figure 2 Design 1

made small enough to be convenient for the golfer, it would be prone to breaking when bouncing around in the golfer's bag or if it fell out of the golf cart.

The second design that was discussed used four pins that would be activated into the grass by springs. These four pins would surround the ball mark and enter the green at an angle, simulating the golfer inserting their fork tool around the ball mark numerous times. Again this device would attach to the end of the putter to allow the golfer to avoid bending over. When the player pulled their putter with the attached tool out of the ground, the pins would move from an angle to being vertical in order to fix the ball mark.

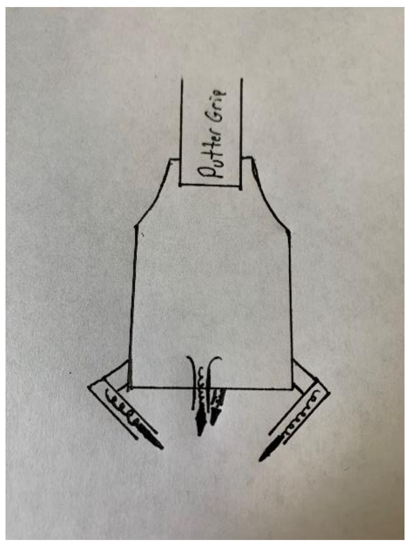

Figure 3 Design 2

The third idea was created with an out of the box approach. Instead of thinking how ball marks were conventionally fixed, a theory was created on a new way to fix them. The idea would incorporate a sharp metal cone that would be pushed into the ground by a spring. As the cone entered the grass, the walls of the cone would force the grass and dirt that was lifted by

the ball mark towards the center of the indent. The player would then be able to use their putter to flatten the grass in dirt in the middle to return the green to a flat surface.

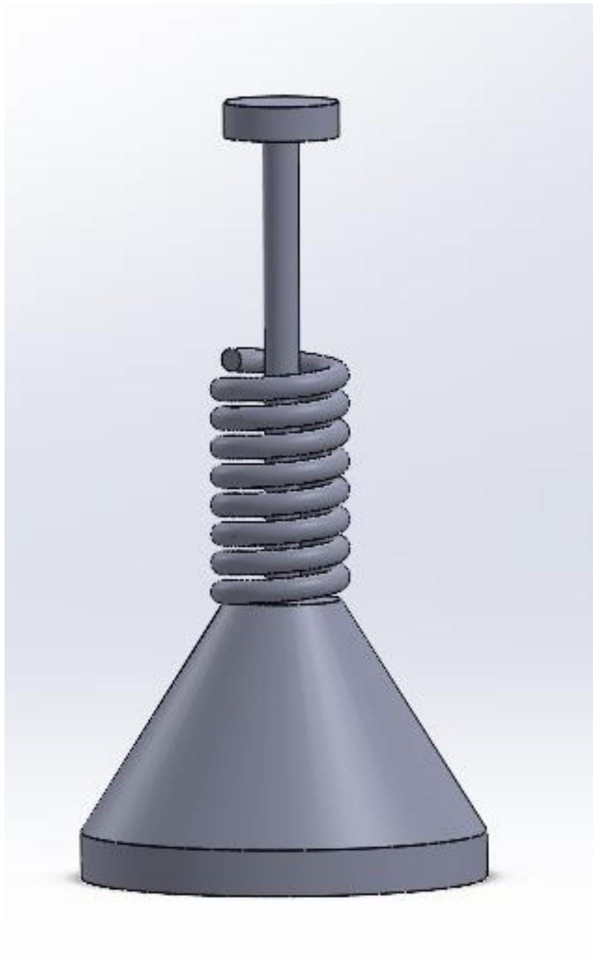

Figure 4 Desgn 3

An initial concept of this idea can be seen in figure 4 above. A housing would be created where the top of the spring would attach to secure it in place. Also, part of the housing would be a method of attaching the tool to the grip of the putter. The bottom diameter of the cone would be 2.5 inches in order to fix a majority of the ball marks that were recorded in the data collection phase.

Before the final product of this design was made, a prototype was created to validate the theory of a cone being used to fix a ball mark. A cone with similar dimensions to the initial design was found and pushed by hand into the ground. Although the cone did fix the ball mark during initial tests, a circular mark was left around the fixed mark from the cone digging into the ground. It was decided that this mark left by the cone caused too much damage to the green so the design had to be changed. Another prototype was created to test a cone with a rounded bottom. The idea was that the rounded bottom would keep the cone from digging into the grass but still be able to press in slightly in order to utilize the walls of the cone to fix the ball mark.

Figure 5 Prototype

During testing of the second prototype, it was found that a straight push down would not fix the ball mark. Instead, a circular motion created while putting pressure on the edge of

the cone allowed the grass to be pushed towards the center of the mark. Using this motion, the prototype was deemed a success and would move on to the final design production.

2.2 Details

After the success of the rounded bottom cone prototype, changes were made in order to finalize the design. Since the cone no longer had to dig into the ground, the spring and rod were no longer needed. Instead, the cone would be attached directly to the designed grip to attach to the putter.

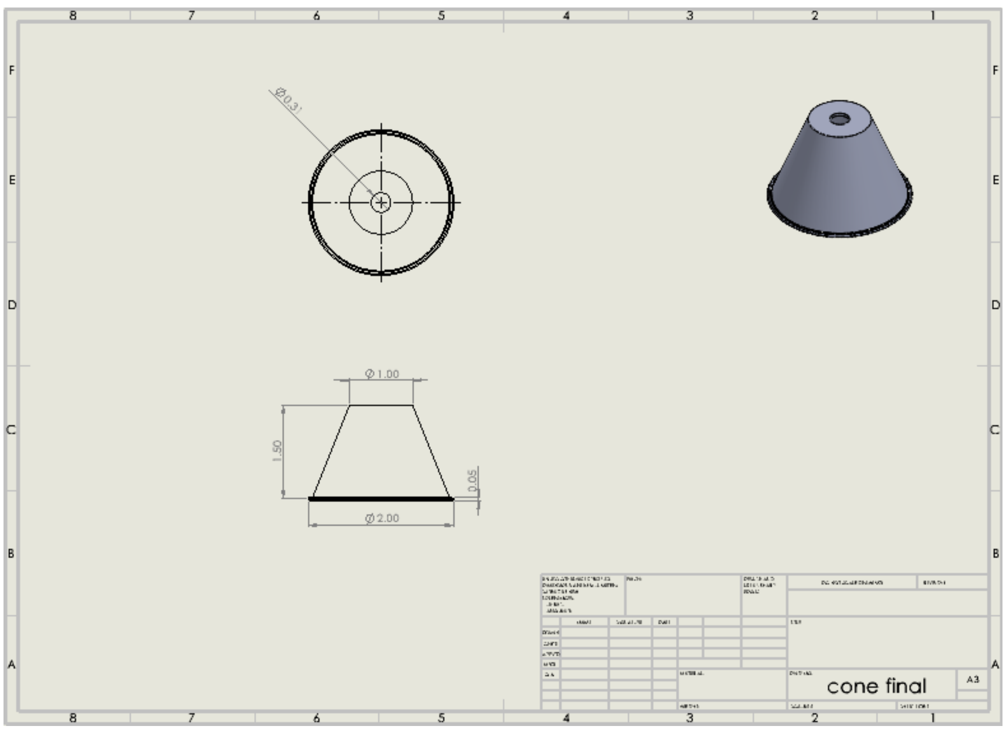

Figure 6 Cone Drawing

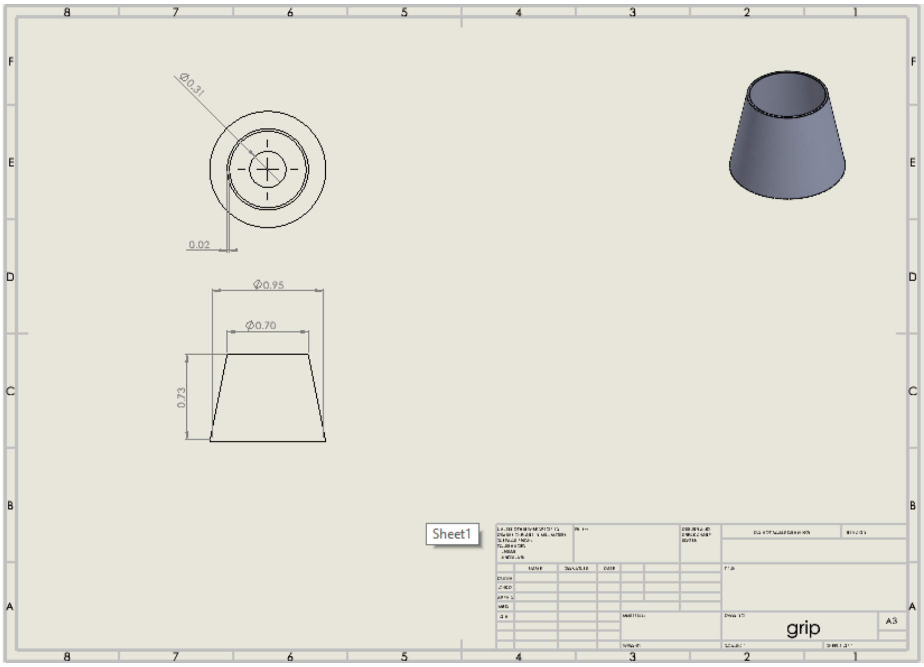

Figure 7 Putter Grip Drawing

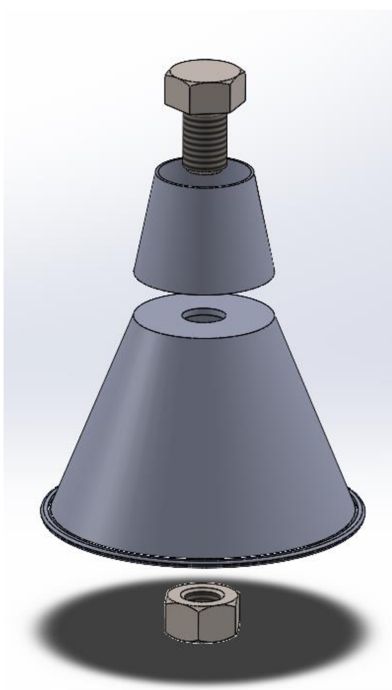

Figure 8 Assembly Exploded View

When acquiring parts for the final design production, the metal cone with rounded edges was found almost exactly to the design specifications which saved money from having to manufacturing or special order the part. For the rubber grip, it was desired to have a hard rubber that allowed a small amount of stretch to fit varying putters grip sizes while also still holding securely to the putter. Although the exact rubber piece designed could not be obtained at a reasonable price, a part was found that would securely attach to the putter with extra rubber at the bottom to partially surround the rubber cone. The bottom rubber piece did not fit perfectly on the metal cone so molding putty was used to adhere the two pieces together avoid wiggle room between the two parts. The rubber grip part and the metal cone were fastened together use a 5/16 – 18 bolt and nut. A washer was added to the bottom of the rubber piece to add strength to the neck of the design where the rubber was bending when using the tool. After first trying the final design, the bolt was switched with a low-profile machine screw so the putter grip could go farther into the rubber piece for a more secure fit.

Figure 9 Final Assembly

Figure 10 Final Product Attached to a Putter

3. Design Verification

In order to confirm that the final design of the product worked effectively at fixing ball marks on greens, a standardized way to test the product would have to be developed. To accomplish this, a Stimpmeter was manufactured. A Stimpmeter is a device that is used by grounds crew workers in order to measure the speed of a ball on a green. This is done so the grounds crew can find a sufficient place to put the hole for the flag. In this project, the Stimpmeter was redesigned, so it could consistently roll a ball across the ground at a constant speed for each trial. This would allow accurate rolls of a golf ball consisting for the speed and direction of the ball.

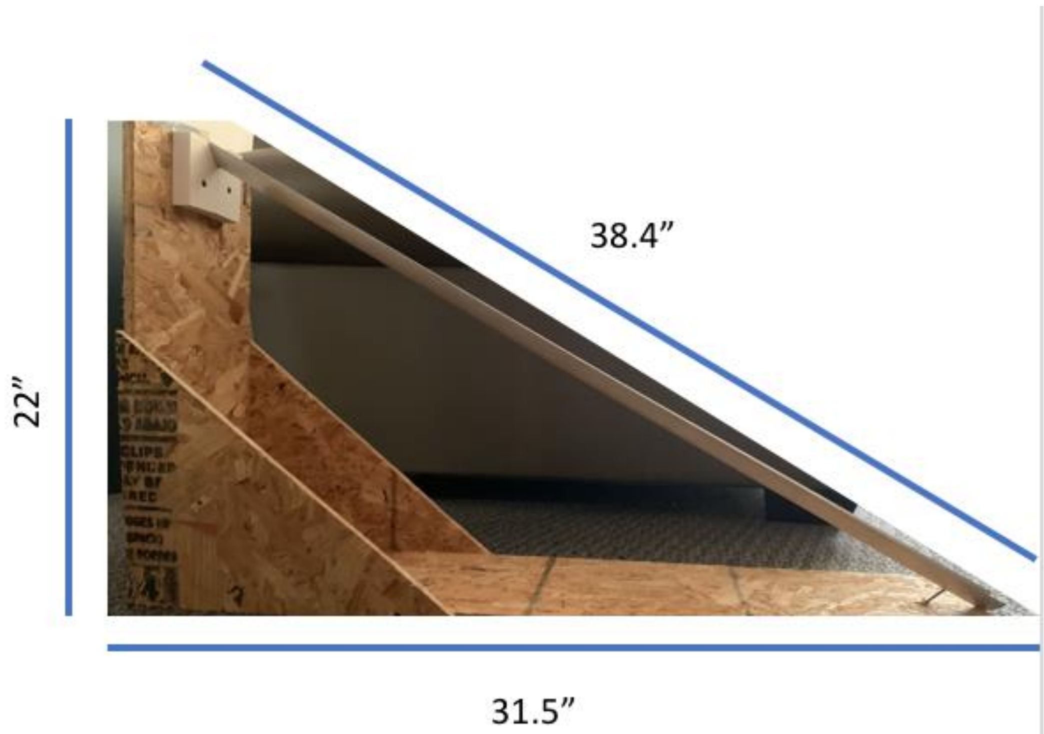

Figure 11 Stimp Meter

To test the effectiveness of the ball mark fixer, the Stimpmeter was taken to a practice green. At this green, there were four separate pin locations that were to be used for the testing. The four pin locations offered different slopes that the path of the ball would be rolling on after it left the Stimpmeter. For each pin location, the testing went as follows; the Stimpmeter would be placed at a specified distance away from the pin. A golf ball would be placed at the top of it and let go, so it can consistently roll at the pin. The golf ball would be released ten times without any ball marks in the way. After that, ten more rolls would happen, but there would be a ball mark in the path of the ball. Finally, the ball mark would be fixed with the ball mark fixer, and the ball would be released so that it could roll over the fixed ball mark. This process occurred at all four pin locations, and the number of times the ball rolled into the pin location was counted.

3.1 Testing Results

The table below shows the data collected from the Stimpmeter testing at the practice. In total, a golf ball was rolled 120 times at four different pin locations. Forty rolls occurred with no ball mark in the path of the ball, forty rolls occurred with a ball mark intruding the path of the ball, and forty rolls occurred with a fixed ball mark in the path of the ball. From this data, there was a 20% increase in balls made when the ball mark fixer was used to fix the ball mark that was in the path of the ball.

Stimp Meter Testing			
	Location: Mud Run Golf Course - Practice Green	Date: April 3, 2021	
	Rolls Made	Rolls Attempted	% Made
Practice Hole 1			
No Ball Mark	7	10	70%
Ball Mark	5	10	50%
Fixed Ball Mark	7	10	70%
	Rolls Made	Rolls Attempted	% Made
Practice Hole 2			
No Ball Mark	8	10	80%
Ball Mark	4	10	40%
Fixed Ball Mark	6	10	60%
	Rolls Made	Rolls Attempted	% Made
Practice Hole 3			
No Ball Mark	8	10	80%
Ball Mark	6	10	60%
Fixed Ball Mark	7	10	70%
	Rolls Made	Rolls Attempted	% Made
Practice Hole 4			
No Ball Mark	8	10	80%
Ball Mark	3	10	30%
Fixed Ball Mark	6	10	60%

Figure 12 Testing Results

4. Costs

The prototype ball mark fixer was assembled with minimal components. The goal was to use as little pieces as possible to assemble the design in order to reduce the changes for failure and increase repeatability. The two main parts are the rubber grip and the cone. The rubber grip attaches to the cone with a small amount of silicone. Referring to the table in section 4.1, the rubber grip costs $4.85 and the cone is $5 for retail cost. With bulk manufacturing and purchasing, the price can be reduced to $3 for the rubber grip and $2.50 for the cone. This brings the total bulk purchase cost to $5.50. Selling the product online, the shipping cost utilizing USPS with a small flat rate box is currently $8.05 anywhere in the United States. Shipping the product in bulk to golf courses or distributors will cost significantly less. Approximately $1-$3 per part depending on the quantity ordered.

4.1 Parts

Part	Manufacturer	Retail Cost ($)	Bulk Purchase Cost ($)	Actual Cost ($)
Rubber Grip	Amazon	4.85	3	-
Cone	Amazon	5	2.50	-
Total		**9.85**	**5.50**	**-**

Figure 13 Cost Sheet

4.2 Labor

The average starting salary for a Mechanical Engineering in Akron Ohio is $67,879 (salary.com). Working 8 hours per day Monday-Friday, the Mechanical Engineer is paid $30 per hour. This converts to 51 cents per minute. The time required in order to assemble the

components is 1 minute per part. Therefore, labor cost is an additional 51 cents per product.

The final cost of the product purchased in bulk with labor is $6.01.

5. Conclusion

5.1 Accomplishments

The first big accomplishment in this project was developing a prototype that mimicked the repair motion of the conventional ball mark repair tool. This prototype provided the design group with the confidence that an reliable and accurate design could be produced. The second big accomplishment in this project was finding a way to securely attach the cone to the putter grip. A rubber piece that was sturdy enough to hold the cone in place, while being securely attached to the putter grip was a huge development. The addition of adhesive putty between the cone and the rubber piece made the final product even more effective.

5.2 Uncertainties

An uncertainty that arose during testing had to do with the homemade stimp meter. Because of the design of the testing apparatus, the ball bounced slightly when it was rolled on to the green. During a typical putt, this would not occur so it may have slightly thrown off results. Another uncertainty with testing was not recording test results for fixing a divot the conventional way. The reason this did not happen is because the golf course where testing occurred wanted to minimize the ball marks that were made on their practice green. Also, the ball marks that were made for testing were man made instead of natural ball marks from a golf shot. This had to be done because the course employees did not want testing to hold up the other golfers on the course.

5.3 Ethical considerations

This ball mark fixer is an ethical product as it was designed to be a more convenient tool for golfers than what currently is available. The main target of this product is for golfers who have a hard time bending over especially the older golf population. Currently there are no other ball mark repair tools on the market to help golfers who struggle bending over for an extended period.

5.4 Future work

Future work regarding the ball mark fixer would involve finding a rubber and metal manufacturer that would be able to produce the design to the specifications that were determined. Different iterations of the metal cone and the rubber housing could be easily produced, and this would provide an option for different designs. This would industrialize the ball mark fixer and make it easier for mass production, if a patent were ever to be filed.

5.5 Standards

During the design and manufacturing process, it was important to keep in mind that one must follow ASME standards. For example, it was important to follow a certain design process to address and choose a path that will result in a successful product. The design process taught in Concepts of Design is a universal engineering design process that every engineer uses a form of. Evidently, one must start with an idea and get some basic sketches as to what he or she wants the product to look like and how it should function. From there, it is important to consider several different ways on how the product will function and choose the most effective

path. This is called a functional decomposition (Figure 2). Once the path is chosen and working hand in hand with the weighted decision matrix that was also created, then the actual manufacturing begins. Testing and the corresponding results are then recorded.

References

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[2] “Equipment Rules-Putter Grip.” *USGA*, United States Golf Association, 15 October 2019 www.usga.org/equipment- standards/equipment-rules-2019/equipment-rules/equipment-rules.html#!ruletype=er§ion=rule&partnum=2&rulenum=4.

[3] “Repairing Ball Marks.” *USGA*, United States Golf Association, 9 July 2018, www.usga.org/articles/2018/07/repairing-ball-marks--5-things-every-golfer-should-know-.html.

Appendix A Requirement and Verification Table

Table 13 System Requirements and Verifications

Requirement	Verification	Verification status (Y or N)
Attach to putter to avoid bending over	Grip fits on normal and jumbo-sized putter grip	Y
Properly fix ball mark	See testing results (Figure 11)	Partial
Avoids long term green damage	Fixed marks checked after one week for dead grass spots	Y
Competitive cost in marketplace	Be able to sell for $20 or less	Y