MANUFACTURABILITY, RELAIBILITY, ECONOMICS

EML4550C – Senior Design Spring 2016

TEAM 17 - "IMPROVED DOG GROOMING TOOL"

Sponsors - Bill Bilbow, Todd Hopwood

Team Advisor – Dr. Simone Hruda

Course Advisor – Dr. Nikhil Gupta, Dr. Shih

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Submitted To: Dr. Nikhil Gupta

Authors: Justin Proctor *(Team Leader)*

Jordan Chupp *(Secretary)*

Dennis Pugh *(Treasurer)*

Roy Mason *(Web Designer)*

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Team 17 Biography

Justin Proctor is the team leader of Team 17. He is also an active member of the student chapter of Society of Automotive Engineers, were he serves as the head of the Baja Racing rear suspension unit. In his spare time Justin enjoys working on white Mazda Miata as a project car.

Jordan Chupp is the Team Secretary for Team 17. He is in charge of making sure that all notes are taken and that all minutes from any meetings we conduct are recorded. Justin is into archery as he likes going out to shoot his crossbow

Dennis Pugh is the Treasurer for Team 17. He is the head of managing our accounts, how much we have spent and what we have to spend. He is also in charge of submitting and keeping record of receipts, invoices, and any purchase orders. Dennis is a member of the Florida A&M University's Track and Field team.

Roy Mason is Team 17's Web Designer and Editor. He is responsible for editing and creating the layout of Team 17s webpage, as well as formatting, editing, and finalizing all reports and presentations for submission and use. Roy Mason is an active member of the Florida State University chapter of the Society of Automotive Engineers, were he serves on the executive board as club treasurer. He is also a part of the Baja Racing brake design unit. Roy Mason enjoys pencil sketching, playing basketball, and studying the Bible.

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Team 17 would also like to give thanks to Dr. Nikhil Gupta as well as Dr. Shih, for their continued guidance, evaluation and constructive criticism. Dr. Gupta and Dr. Shih have helped motivate Team 17 to stay on task and to have good schedule management.

Team 17 would like to express in gratitude to its team sponsors, William Bilbow and Todd Hopwood. Team 17 is grateful for them for providing them with the opportunity to even embark on this project by being the first team to be a part of their engineering entrepreneurial incubating initiative. Team 17 would like to thank them for their support both financially and through the preliminary design and planning process.

A special thanks would like to giving from Team 17 to all those who participated in the consumer survey, with a major thanks to the Lori Williams at Paws and Claws for her willingness and openness to participate in the research and testing and trial phase.

Abstract

All dog coats, require consistent maintenance and upkeep to prevent painful matting, maintain cleanliness and preventing bad odors. The Improved Dog Grooming Tool project, is an engineering endeavor that looks to provide a solution to the problems dog owners and caretakers face when it comes to grooming their dogs. This project is sponsored by Todd Hopwood and William Bilbow, two professional engineering business owners. The current process of manually brushing hair and removing mats from dog fur is a time consuming, and strenuous task for caretaker and at times the dog. In-depth research was conducted to identify current tools used for grooming tools and the issues people deal with while using them.

1. Introduction

Team 17 has been selected to provide a solution for the unpleasant grooming experiences of dogs and their caregivers, through the design and construction of a tool, which will allow a dog's coat hairs to be detangled and ordered using a process that is non-stressing for the groomer, and pleasant for the dog.

Team 17 has successfully developed a brush, Figure 1 that targets preventative methods to dog fur matting through an improved electrical dog brush. The team has gone through the manufacturing process of cost effectively fabricating a prototype that has also been tested through brief computational analysis

Figure 1: Improved Dog Grooming Tool

2. Manufacturability

2.1. Fabrication

Prior to assembly, various parts of the brush assembly required fabrication. Parts were either fabricated in house, at the College of Engineering machine shop, or were outsourced to shops with access to 3d printers. The handle was designed to be 3d printed to reduce cost as well as manufacturing time. The handle was designed as a two-piece assembly to reduce assembly time as well. The motor shaft was the only other part that required much fabrication time. In order to reduce labor time as much as possible, a prefabricated power drill extension bit was modified to fit the application. Due to the complexity of machining the hex socket in the end of the bit, modifying a pre-fabricated bit was the cheaper and quicker method to take. In order to adapt the drill bit extension to the brush application, it was necessary to cut it down to the appropriate length as well as machine a hole on one end for the motor shaft to fit into.

Due to the complexity of manufacturing a brush head, it was decided to use prefabricated brush heads that are commonly available and adapt them to work with this application. Very little fabrication time was required by doing so. The only modifications required to make the brush heads attach to the motor shaft was to remove the old handle from the brush head and attach a short piece of ¼” hexagonal stock which fits into the existing hole in the drill bit extension. This was done by drilling a ¼” hole and using a hexagonal broach, provided by the College of Engineering machine shop, and pressing in the hexagonal stock.

Other brush components, including the motor, switch, bearings, and power source, were all purchased prefabricated. Due to the complexity of these components, as well as their availability, it was found the quicker and more cost effective to purchase as many parts as possible versus custom fabricating them.

2.2. Assembly

Once fabrication of the components was completed, assembly of the components could begin. Because the brush was designed with ease of assembly in mind, assembly time and labor were kept to a minimum. The internal components of the brush handle required no assembly of their own so they were able to be dropped into their respective slot which was designed into the handle. The motor, shaft, bearings, and switch all had specific slots in the handle where they simply dropped in and were held solidly in place. Once fit of these internal components was checked, the motor switch and power source were wired together. This step was the most time consuming as the terminals on the motor and switch required the leads to be soldered on. After wiring was completed and the motor was checked for rotation, the two handle halves were joined together and held in place by three screws.

As stated earlier, the brush was designed with ease of assembly in mind. The cutouts for the internal components of the brush allowed to be quickly dropped in place and required no extra securing. The number of components was also kept to an absolute minimum. This was primarily driven by the weight constraint placed on the project, but also cost concerns when fabricating and assembling. By taking these extra steps when designing, it allowed the initial prototype to be completely assembled in roughly one hour’s time, the bulk of this time devoted to wiring. With more practice and an assembly line method, this time could be reduced much further. Mass production of these assemblies would then be very possible.

Table 1: Brush Bill of Materials

ITEM NO.	DESCRIPTION	QUANTITY
1	60 RPM DC Motor	1
2	Motor Shaft Adapter	1
3	Motor Shaft Bearing	2
4	½ Grooved Handle	1
5	½ Grooved Handle Counterbored	1
6	Reversible Power Switch	1
7	¼-20 Cap Screw	3
8	Brush Head	1

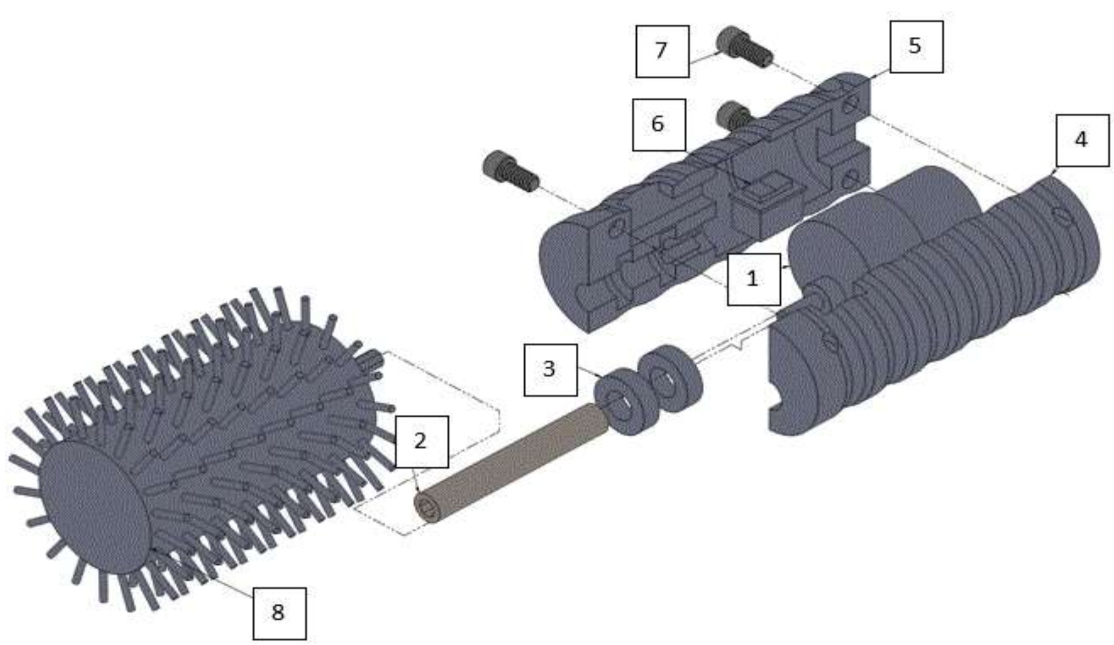


Figure 2: Brush Assembly Exploded View

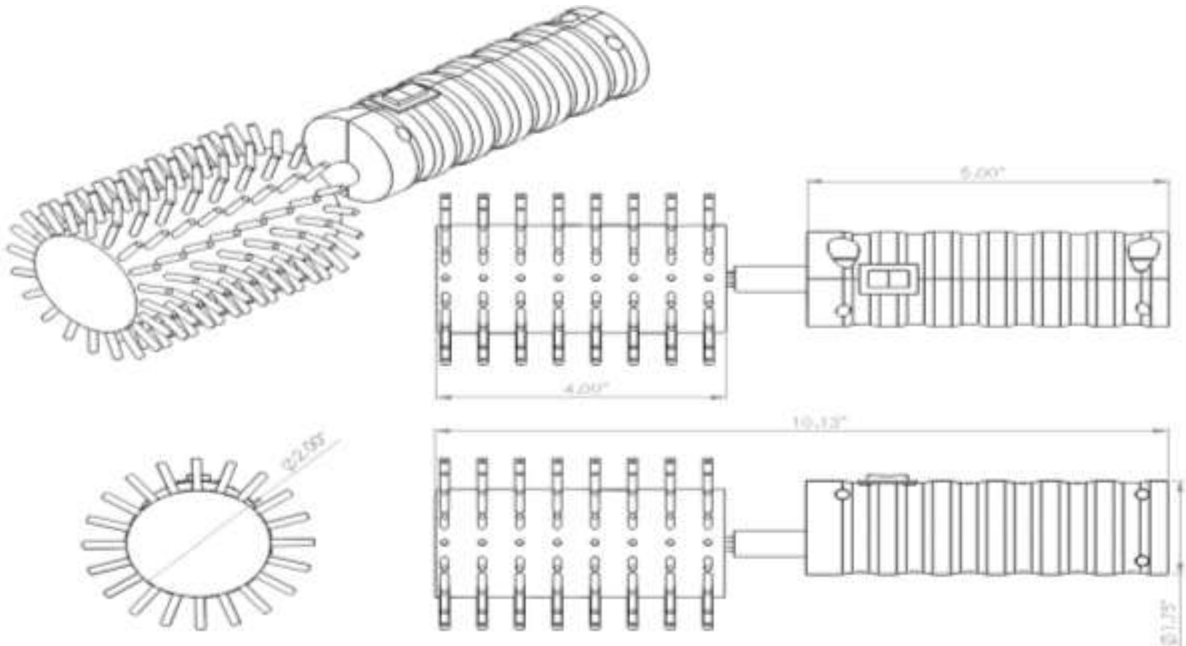


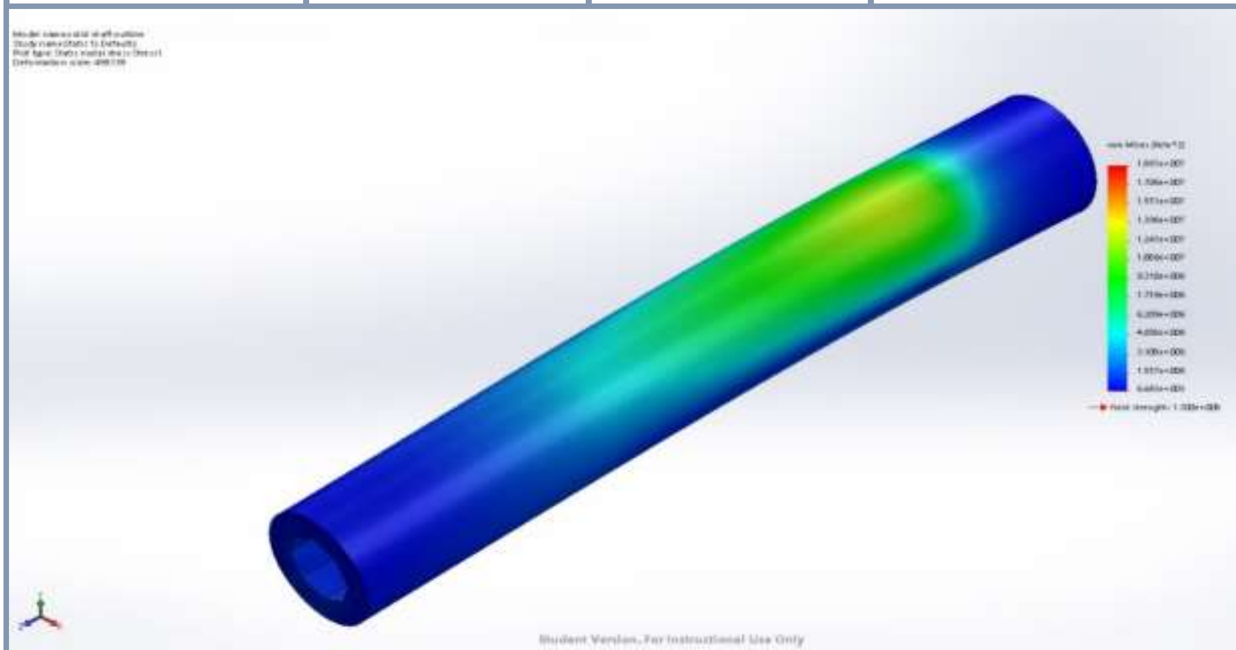
Figure 3: Brush Assembly Drawing

3. Reliability

3.1. Motor Shaft Adapter FEA

FEA was conducted on the motor shaft adapter to determine how the shaft would handle the various loads that it would see. The motor adapter shaft was implemented into the design to attach to the motor shaft so that it would endure the various bending and torque loads during brushing that would otherwise cause the motor shaft to fail. From the FEA results of Von Mises Stress it is seen that the adapter shaft handles the stress substantially well. Though difficult to read, the yield stress of the shaft is approximately $\sigma_y = 1.7 * 10^8 \frac{N}{m^2}$, from Figure 4 it can be seen that the highest Von Mises stress that the shaft could possible see is only $\sigma_1 = 1.86 * 10^7 \frac{N}{m^2}$, and from Figure 4 it can be seen that the shaft never sees that stress level

Name	Type	Min	Max
Stress1	VON: von Mises Stress	6643.38 N/m^2 Node: 121	1.86124e+007 N/m^2 Node: 9832



solid shaft outline-Static 1-Stress-Stress1

Figure 4: Shaft Adapter FEA

4. Economics

The whole product will cost around $12 and sell for the price of $35. The final prototype costs $90. This price is high due to 3-D printing the handle and buying all the other parts in single orders. Buying in bulk and manufacturing our own brush heads will drive down this cost to the target cost of $12. The prices for the individual parts that we used for the prototype are in Table 2. There shows the components name and their respective cost. Another way to illustrate the individual component and its cost is represented in Figure 5. There shows the budget breakdown and how every dollar so far has been spent. We bought multiple motors and brush heads which is why those costs in that Figure 4 do not match the costs in Table 2.

Table 2: Costs for Parts

COMPONENT	COST
MOTOR	$16
SHAFT	$10
BEARINGS (2)	$10
BRUSH HEAD	$9
HANDLE	$30
POWER CONVERTER	$10
SWITCH	$5
TOTAL	$90

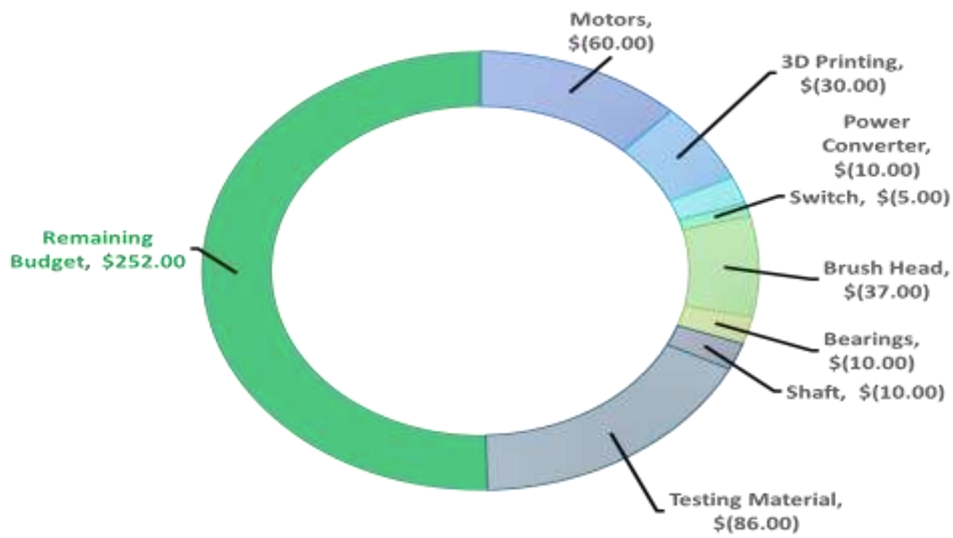


Figure 5: Pie Chart of Project Budget

5. Conclusion

Grooming a severely matted animal can be a long, stressful, and tiring process. This goal of this project is to make the grooming process much more enjoyable for both the pet and groomer. The team plans to examine the current methods used for grooming in order to develop an ideal product for future use. The team will use the resources of shadowing current groomers to learn the techniques used and issues encountered to continue the product design from an informed position