

Pet Cleanup Project

Detailed Design Review

Group C

Angelina Barone

Mira Faizul

Dan Haikal

Ranga Rutiser Sundar

ENGR 1182.01 (26469)

Dr. Edgar Paul Casale

20 April 2022

Table of Contents

Table of Contents	2
Detailed Design Review	3
1. Project Management	3
1.1. Finalized Prototype Plan	3
1.2. Goals and Deliverables	3
1.3. Project Management Schedule	3
2. User Validation Plan	4
2.1. User Needs	4
3. Social and Economic Value	5
3.1. Value Matrix	5
3.2. Narrative	6
4. Detailed Design and Manufacturing	6
4.1. Prototype Fabrication and Evaluation	6
4.2. Detailed Design	6
References	8
Appendix A: Project Management Schedule	9
Appendix B: Working Drawing Packet	10
Appendix C: Prototype Images	15
Appendix D: Group Responsibilities	17

Detailed Design Review

1. Project Management

1.1. Finalized Prototype Plan

A swivel brush designed for pets is chosen to be the group's final prototype [2]. The hairbrush will consist of five major components prototyped to a mid-range functionality level. The five components will be accompanied by springs and bolts to connect them. While these will not be very smooth and will wear away the plastic over time, for a prototype they are acceptable. The less complicated parts are the handle and back of the hairbrush. These will be made of lightweight and readily available materials like wood or plastic. The rotating hinge supported by the spring is a key feature that will allow users to brush around the pet with less effort. The moving and rotating hinge will adjust to different parts of the pet's body while brushing it. Common materials like bolts and springs will be used to create the hinge. The design of curved bristles was modeled after the papillae on cat tongues. The design of the bristles is meant to collect more hair while also allowing for the hair to be easily removed from the brush. The bristles of the brush are going to be 3-D printed to create a specific curved shape. The hinges and bristles are the main prototyping focus and will be on the higher range of functionality. The group plans to design a prototype that will have an advantage on other products with the different hinges and special bristle design.

1.2. Goals and Deliverables

The main goal of the team is to create a brush that is unique and has advantageous features compared to other products on the market. The bristles are one of the two main focuses of the team. The group is going to design and print bristles that easily gather hair and make it easier to remove the hair from the brush. The group is going to utilize the curved shape of the bristles to accomplish this. The rotating hinges are a highlight in the design of the brush. The hinge will be assembled to curve around the shape of the pet and return to its normal position. The group wanted to create a product that eases the process of brushing a pet. The group is going to create the hinges to work with the user as they try to navigate the brush around the pet's body.

Other than that, the group is also looking forward to inventing a good brush that can make pets happy. The group prioritizes how much the pets seem to enjoy the brushing based on the scorecard that has been created [2].

1.3. Project Management Schedule

The team has produced a comprehensive schedule (Appendix A, Table A1) using a Gantt chart (Appendix A, Figure A1) consisting of tasks that are prioritized to complete the final product on time. All group members have also been assigned different responsibilities to be completed within the time range. If there is a time conflict or past due, the group has to find any available time and finish the task as soon as possible. This schedule will allow the needed tasks to be coordinated between team members.

2. User Validation Plan

2.1. User Needs

To ensure that the end user needs established in the Problem Definition Review [1] for this project are met, a validation plan must be created. In the Problem Definition Review, a pairwise comparison chart was used to rank the user needs to determine their importance to the final design. Using this technique, it was determined that it was most important to be pet-safe, helpful, and easy to use, in that order.

The first change made driven by end user needs was in the bristle assembly. The first bristle prototype failed the first requirement, as its bristles were too sharp, and when tested on a human arm, would mildly scratch the skin. Because of this issue, the first prototype was revised to create a second. The second prototype's bristles are bent farther down and have a larger tip diameter, making them less sharp and harsh on the skin. The bristles are also staggered to collect more hair. This prototype is a vast improvement in pet-safety and efficiency from the first.

In order to make more changes such as this, a method must be established to evaluate how well a prototype meets certain end user needs. Given the limited time available (and the challenge of testing with pets on campus, where most students cannot have pets in their dorms), large-scale user testing is not feasible.

Because of these limitations, user testing must be done by team members and their friends with their own pets. While this creates some drawbacks, as team members who worked to design the product may not have the same view of it as the average consumer, it is not feasible to test the product with more users in the limited time available. The user testing will be done in person which means all team members need to find people who own pets and test the prototype. During the test, the team has to record all results in order to search for any drawbacks of the prototype.

To evaluate how well the prototype meets the top three user needs (pet safety, helpfulness, and ease of use), a simple 1-10 scale can be used. The user will use the brush with their pet and score the brush in each category based on how well it meets that need. The user's name will be kept confidential. The user will also rank the value provided by the brush on the same 1-10 scale. Based on these data, the effectiveness of the prototype can be determined.

3. Social and Economic Value

3.1. Value Matrix

The product offers a significant number of benefits to various stakeholders. These benefits are shown below in Table 1.

Table 1. Value matrix.

Stakeholders	Value Categories			
	Economic	Social	Environmental	Functionality
Pet owners	Generate profits by buying the hairbrush and increase the hairbrush's popularity. There will be more competition in the market since the product has its specific feature which might be implemented by other companies too	Creates a community of pet owners who shares experiences of brushing their pets	A more reliable brush will allow pet owners to own it for an extended amount of time compared to other brushes.	Pet owners can brush their pets more easily with papillae-shaped bristles
Pets	N/A	Bond with pet owners since they feel comfortable when they get brushed	N/A	Gain enjoyment from grooming
Investors	Generate a return on investment through sales.	N/A	N/A	Having a well-performing product is easy to generate more revenue
Employees	Receive payment for work.	Creates a place of work for employees to socialize in	N/A	More complex parts could make more work and take more time

3.2. Narrative

The pet hairbrush is meant to ease the task of brushing pets for the owners. The brush was designed to make it easier to brush around the pet's body and to collect hair faster than current brushes on the market. The stakeholders for the pet hair brush are mostly impacted in the functionality and economic value categories. The pet owners and the pets are the two bigger stakeholders that the group's project is aimed towards pleasing. The functionality of the brush is extremely important as its main purpose is to be easy to use for pet owners and enjoyable to pets. In this way, it can create a special bond between the pet owners and the pets where the pets will not be afraid of the owners anymore. The brush cost is important for pet owners as well. From the surveys conducted for the Problem Definition Review [1], pet owners want reliable and low-cost pet products. Environmental factors for owners are important on a personal preference level. If the brush is more environmentally friendly, the pets will mostly benefit from the functionality aspect of the brush being pet friendly, but it can also be something that the pet enjoys. It could also appeal to a broader range of pet owners, thus increasing the numbers of pet owners. However, as a consequence, the brush will have more competition in the market since every company will compete to produce and promote a better hair brush.

The investors and employees are affected more by the economic value of the pet hairbrush. The more revenue that the brush creates the more jobs and economic value.

4. Detailed Design and Manufacturing

4.1. Prototype Fabrication and Evaluation

The group created the brush to satisfy the user's needs derived from the survey's conducted [1], competing products, and a coalition of different concept designs [2]. The final prototype consists of 6 major parts: the handle, hinge, the back plate, and the bristles. The handle and backplate are straightforward to manufacture. Drawings of these parts are available in Appendix B. Final CAD models are available via GitHub [3].

For a production version, many parts could be combined: the handle and first hinge component could be one injection-molded part. The bristles and backplate could also be combined (they were separate for prototyping to allow rapid iteration of the bristles' design and due to the limitations of 3D printing). The hinge could potentially be replaced by a single flexible plastic piece as well, and the handle could be integrated with the horizontal pivot.

4.2. Detailed Design

A. Final Prototype Design

Based on the group's findings, the most interesting feature that has been implemented in the prototype is the papillae-shaped bristles which were designed to imitate cats' tongues (Appendix B, Drawing 7). Pets, especially cats, frequently get uncomfortable when their owners try to brush them. This design aims to minimize any discomfort for pets.

One of the changes that will be made in the final product is the material used for the bristles. The group aims to use silicone to replace ABS for the brush material since it is much softer and more

flexible. This change will help the brush to provide more comfort to the pets when they get brushed.

B. Revised Grand Concept Design

The initial Grand Concept specified bolts and metal springs, but during prototyping, it was found that this was not an ideal combination. Bolts are quite heavy and do not offer any significant advantages. For the prototype, zip ties were instead used to secure the moving elements together, and their elasticity also provided some spring force to return the brush to a neutral orientation (Appendix C, Figure C1). As a result of this, some parts of the prototype, such as the spring holder (Appendix B, Drawing 6) are not used in the final prototype. A final product would not use zip ties, but by using a single-piece injection-molded plastic part for the hinge, cost, weight, and complexity could be reduced.

In addition, the bristle design was revised between its initial design (Appendix C, Figure C3) and its final design (Appendix C, Figure C2), as the initial design was deemed too sharp to test with pets. The newest version of the bristles are rounded more at the ends and staggered to collect more hair.

The final prototype of the brush changed from the initial concept due to both testing and materials available. The hinge system was changed the most to fit the user needs and prototyping limitations. The springs were removed from the prototype as the zip ties produced a similar elasticity that the group aimed for. The hinge performs well in its current configuration, and it is likely that the addition of bolts and metal springs would negatively impact performance more than it would benefit it. The final prototype adequately meets user needs, and testing shows that the brush is efficient and satisfies many design criteria. Further iter

References

- [1] L. Barone, M. Faizul, D. Haikal, & R. Rutiser Sundar, “Pet Cleanup Project Problem Definition Review,”
<https://github.com/rutisersundar1/ENGR1182GroupC/blob/main/Technical%20Documentation/Problem%20Definition%20Review.pdf> (accessed Apr. 20, 2022)
- [2] L. Barone, M. Faizul, D. Haikal, & R. Rutiser Sundar, “Pet Brush Project Conceptual Design Review,”
<https://github.com/rutisersundar1/ENGR1182GroupC/blob/main/Technical%20Documentation/Conceptual%20Design%20Review.pdf> (accessed Apr. 20, 2022)
- [3] L. Barone, M. Faizul, D. Haikal, & R. Rutiser Sundar, “Pet Brush Project SOLIDWORKS Models,”
<https://github.com/rutisersundar1/ENGR1182GroupC/tree/main/SOLIDWORKS%20Models> (accessed Apr. 20, 2022)

Appendix A: Project Management Schedule

Table A1: Project Management Schedule using Gantt Chart

			Project Start Date	Project End Date	Today's Date
			3/22/22	5/2/22	4/20/22
Task Name/ Description	Approximate work time	Assigned member(s)	Start Date	End Date	Completion percentage
Finish the prototype (P20)	10 hours	Ranga Rutiser Sundar, Angelina Barone	3/22/22	3/30/22	100%
Test prototype (P21)	4 hours	Ranga Rutiser Sundar, Mira Faizul, Angelina Barone	3/28/22	4/4/22	100%
Conduct research to improve prototype (P22)	5 hours	Angelina Barone, Dan Haikal	3/31/22	4/7/22	100%
Improve or modify prototype (P23)	5 hours	Ranga Rutiser Sundar, Angelina Barone	3/28/22	4/14/22	100%
Finalized the prototype (P24)	4 hours	All members	4/4/22	4/21/22	95%
Showcase the prototype (P25)	2 hours	All members	4/21/22	4/21/22	0%

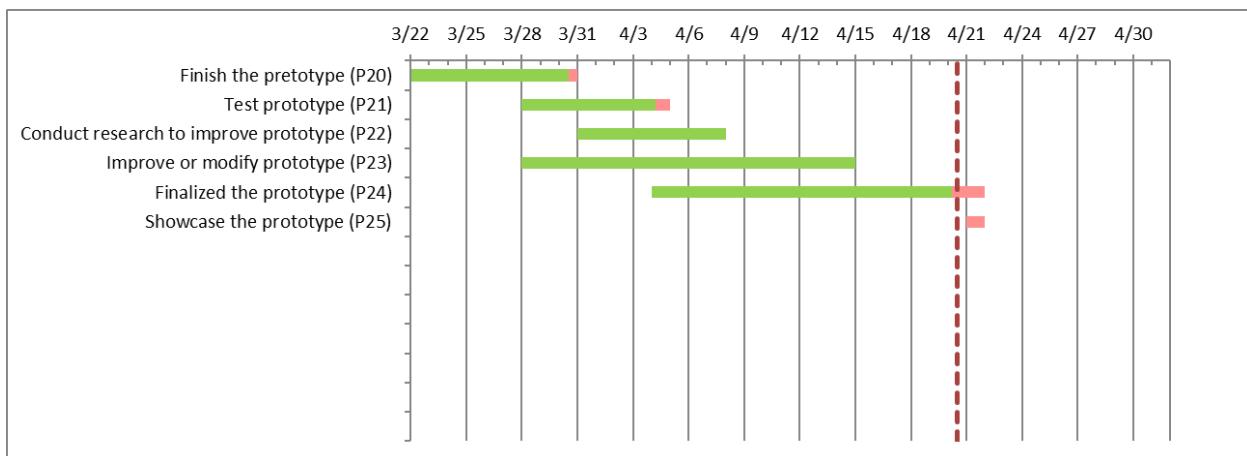
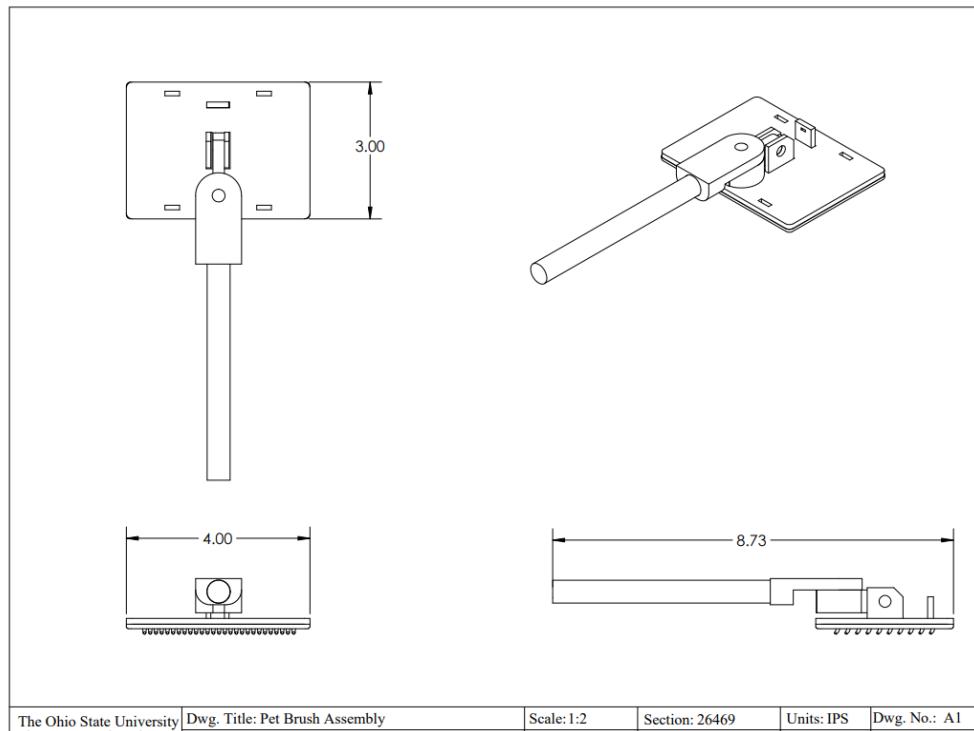


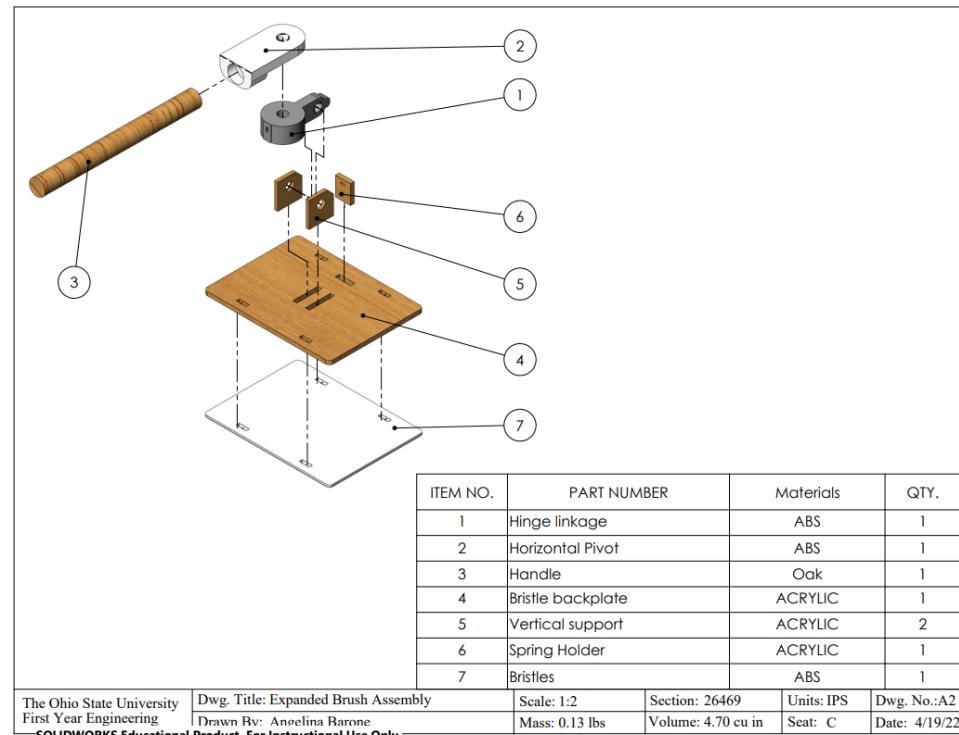
Figure A1: Gantt chart

Appendix B: Working Drawing Packet



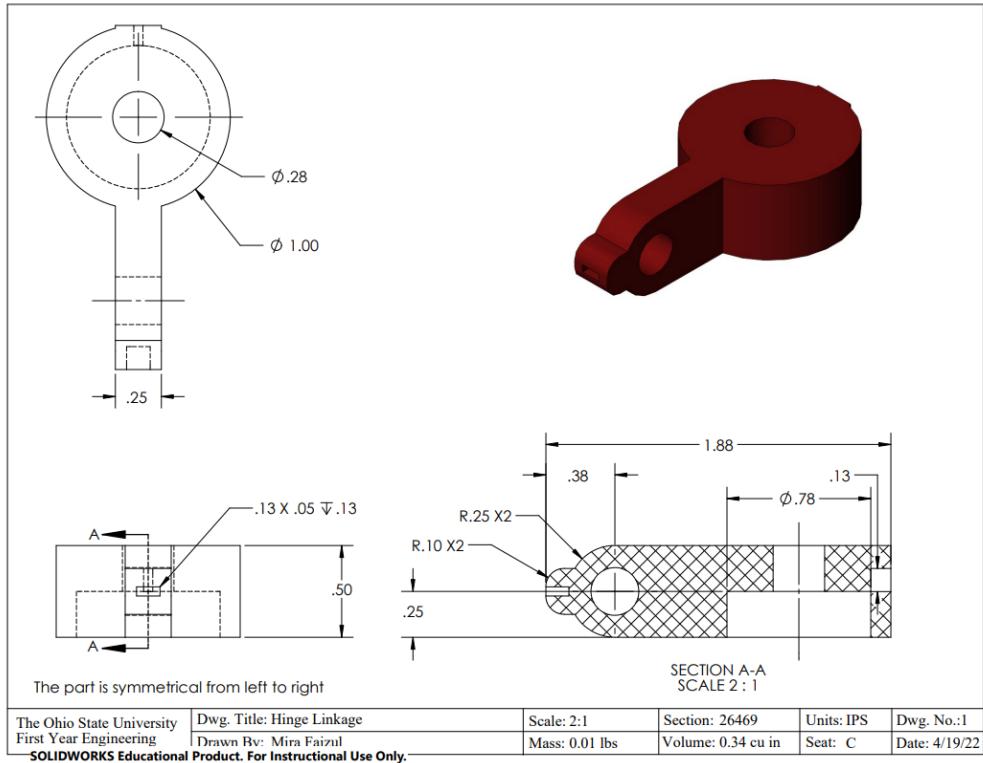
The Ohio State University First Year Engineering	Dwg. Title: Pet Brush Assembly Drawn By: Ranea Rutiger Sundar <small>SOLIDWORKS Educational Product. For Instructional Use Only.</small>	Scale: 1:2 Mass: 0.21 lbs	Section: 26469 Volume: 4.90 CU IN	Units: IPS Seat: 12	Dwg. No.: A1 Date: 04/19/2022
---	--	------------------------------	--------------------------------------	------------------------	----------------------------------

Drawing A1: Pet Brush Assembly

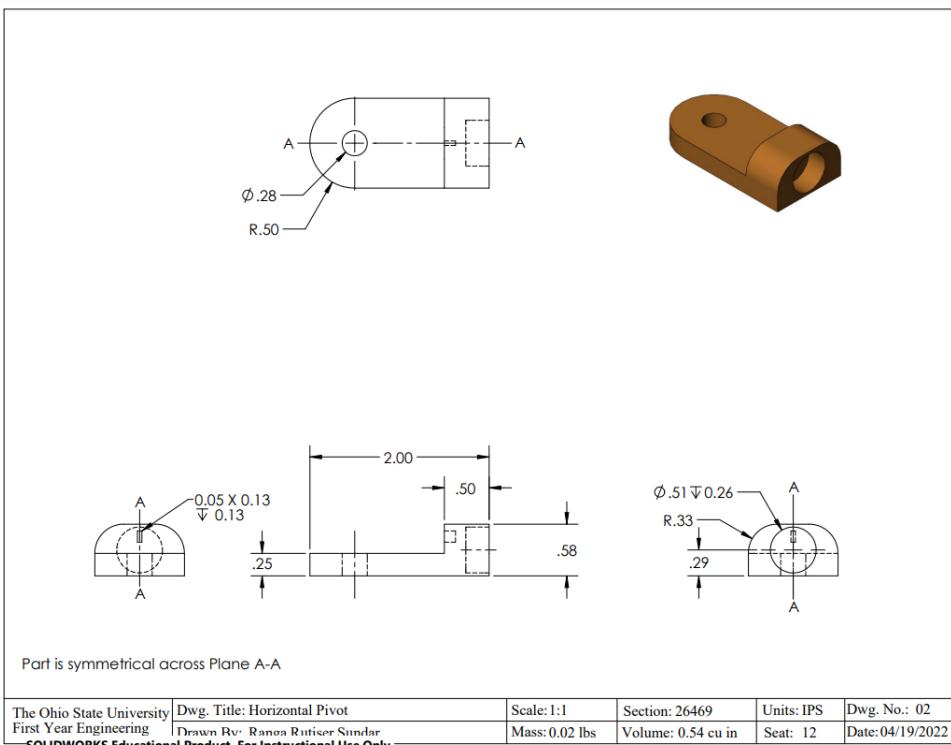


The Ohio State University First Year Engineering	Dwg. Title: Expanded Brush Assembly Drawn By: Annelina Barone <small>SOLIDWORKS Educational Product. For Instructional Use Only.</small>	Scale: 1:2 Mass: 0.13 lbs	Section: 26469 Volume: 4.70 cu in	Units: IPS Seat: C	Dwg. No.: A2 Date: 4/19/22
---	--	------------------------------	--------------------------------------	-----------------------	-------------------------------

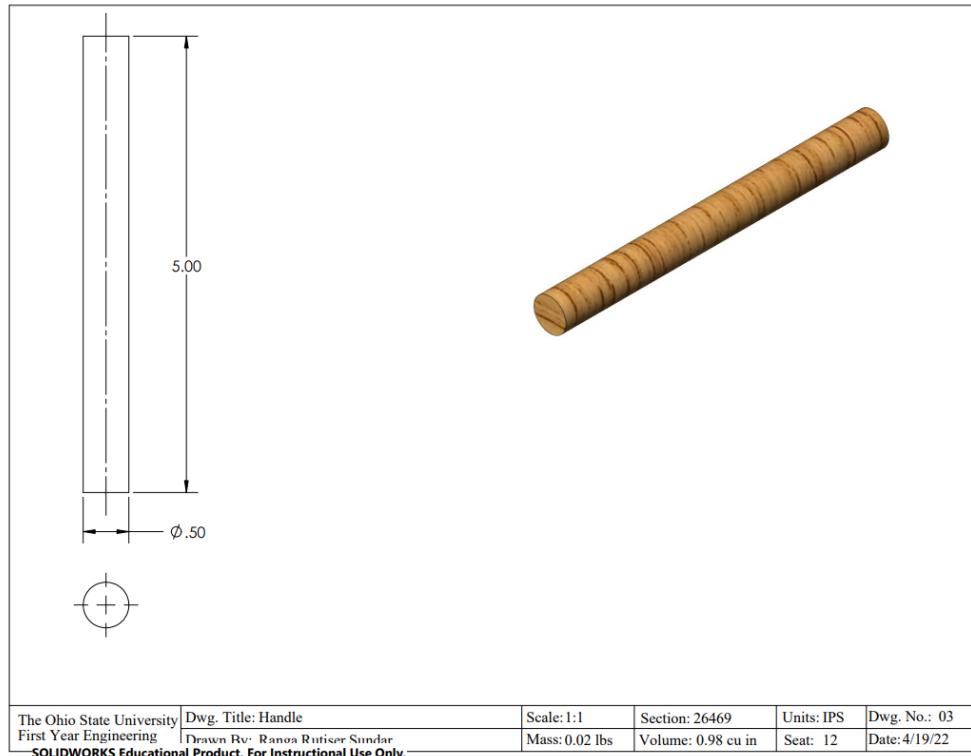
Drawing A2: Exploded Brush Assembly



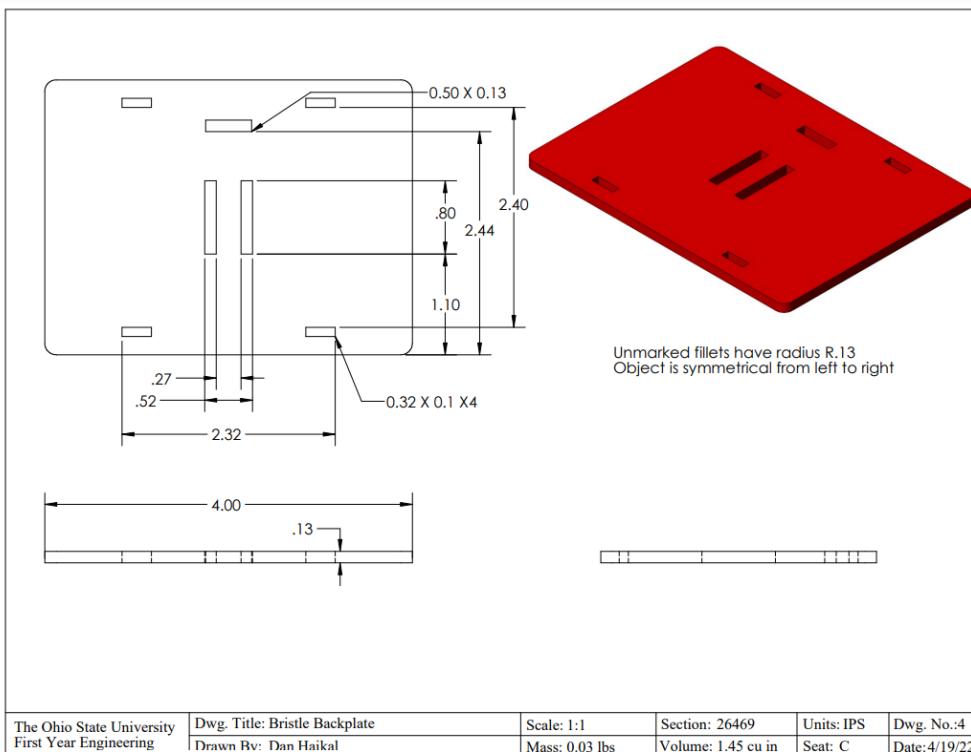
Drawing 1: Hinge Linkage



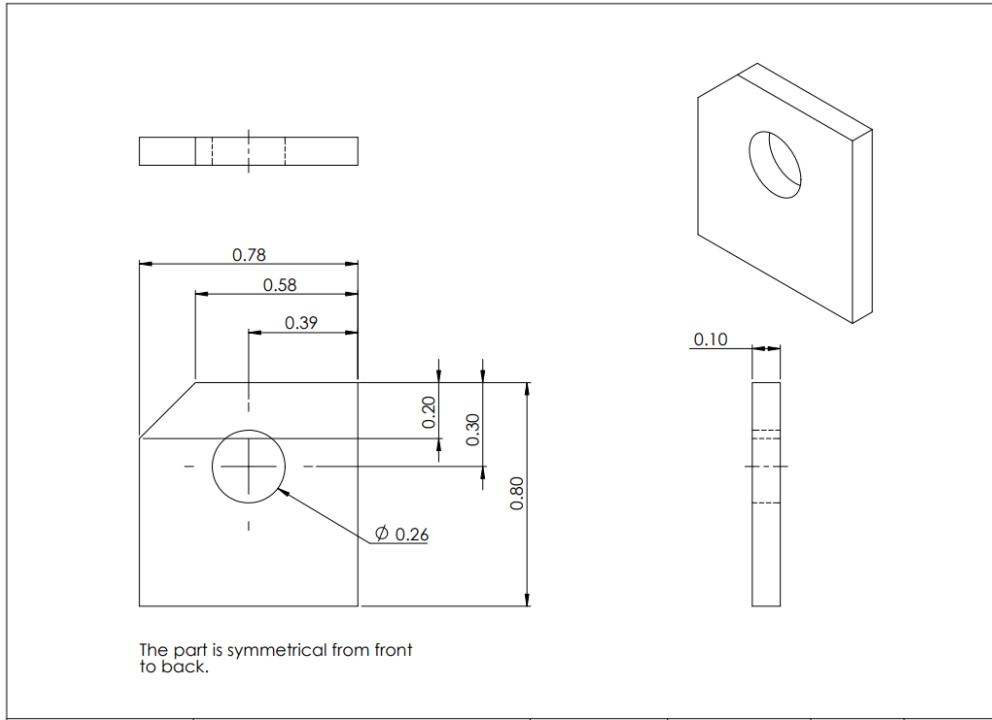
Drawing 2: Horizontal Pivot



Drawing 3: Handle

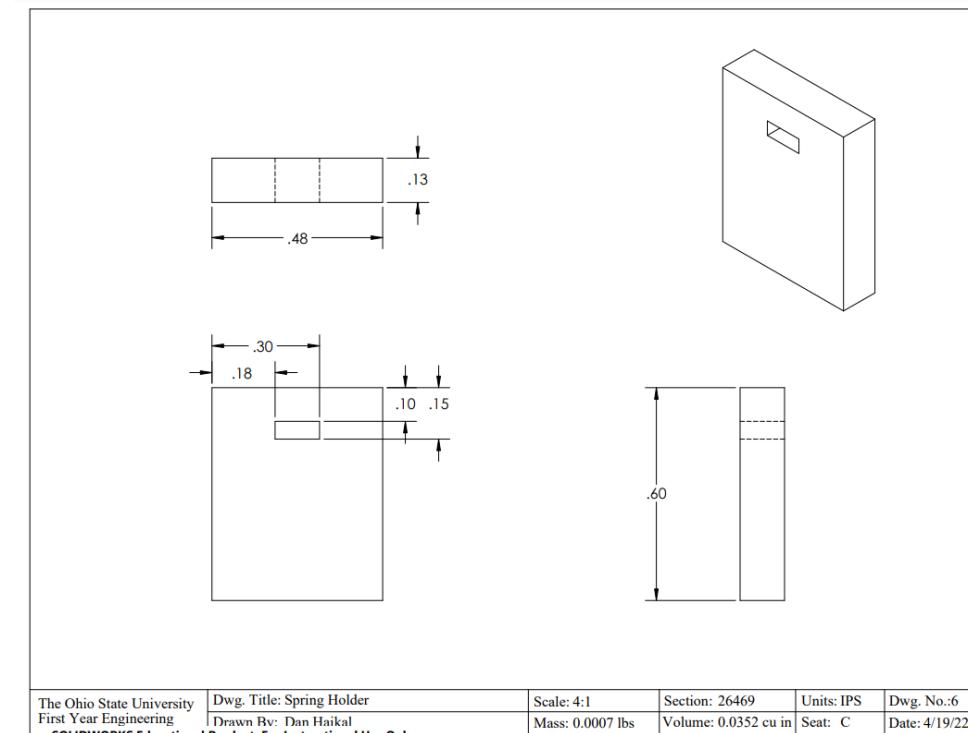


Drawing 4: Bristle Backplate



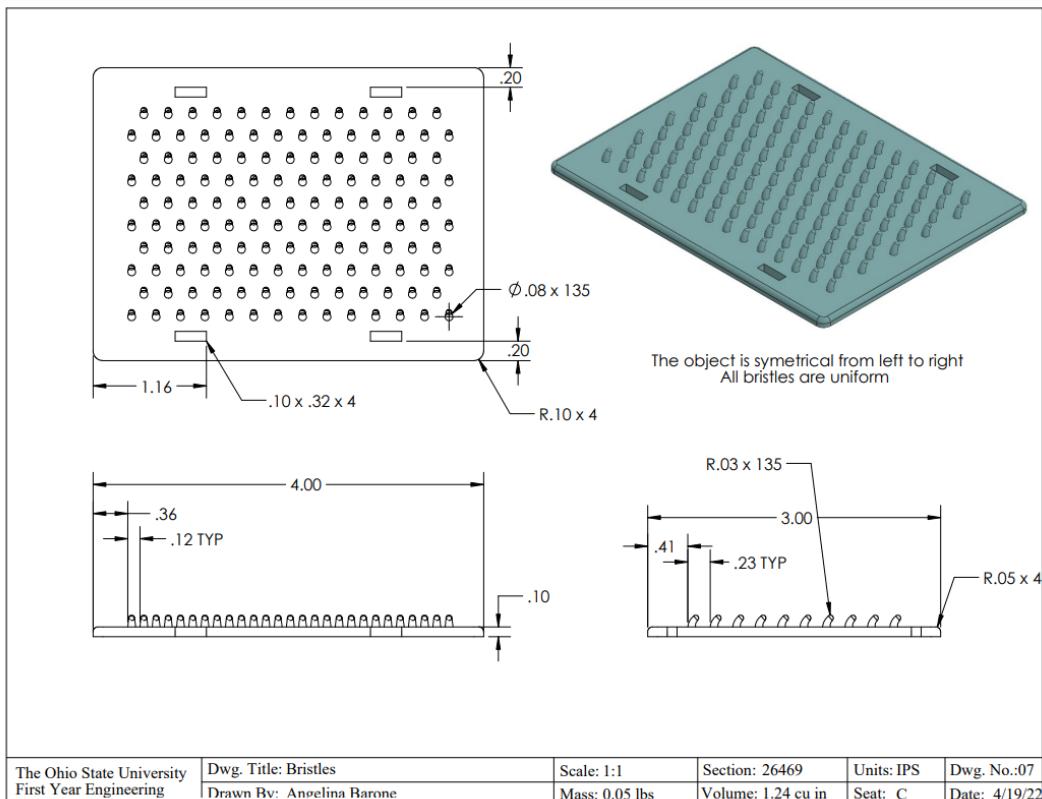
The Ohio State University First Year Engineering	Dwg. Title: Vertical Support Drawn By: Mira Faizul SOLIDWORKS Educational Product. For Instructional Use Only.	Scale: 3:1 Mass: 0.0011 lbs	Section: 26469 Volume: 0.0551 cu in	Units: IPS Seat: C	Dwg. No.:5 Date: 4/19/22
---	---	--------------------------------	--	-----------------------	-----------------------------

Drawing 5: Vertical Support



The Ohio State University First Year Engineering	Dwg. Title: Spring Holder Drawn By: Dan Haikal SOLIDWORKS Educational Product. For Instructional Use Only.	Scale: 4:1 Mass: 0.0007 lbs	Section: 26469 Volume: 0.0352 cu in	Units: IPS Seat: C	Dwg. No.:6 Date: 4/19/22
---	---	--------------------------------	--	-----------------------	-----------------------------

Drawing 6: Spring Holder



Drawing 7: Bristles

Appendix C: Prototype Images

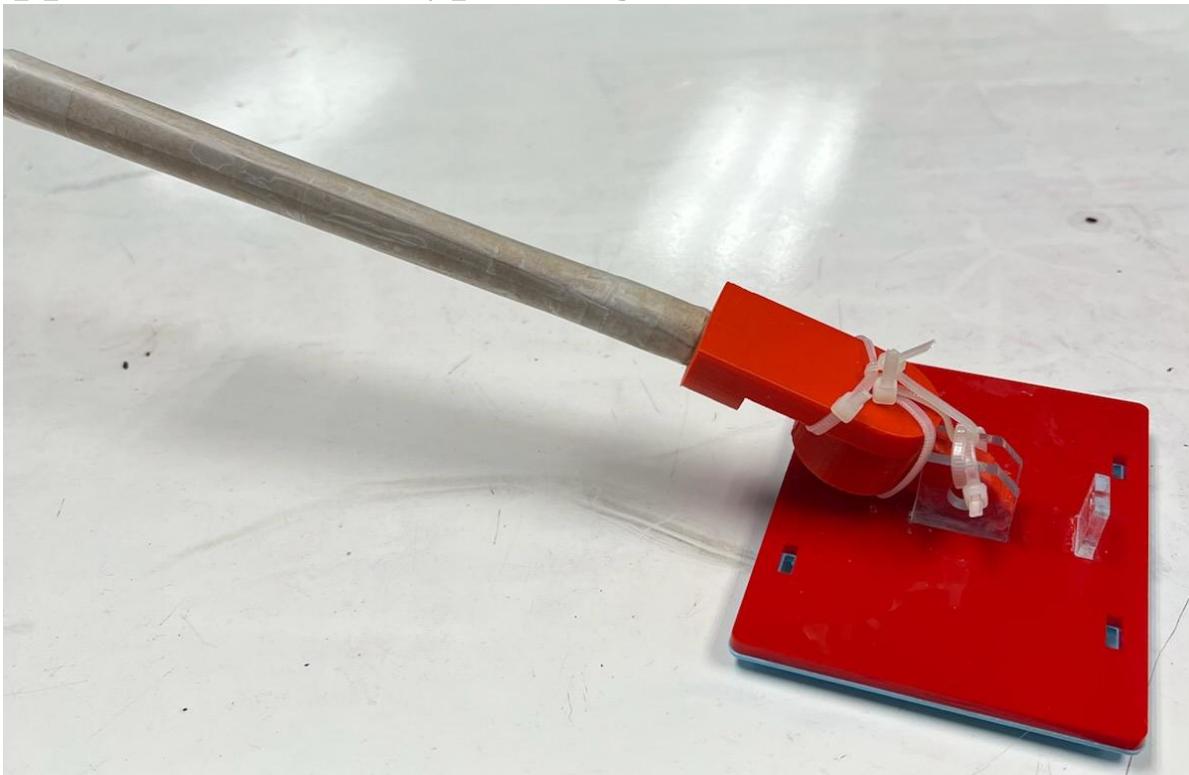


Figure C1: Final Prototype

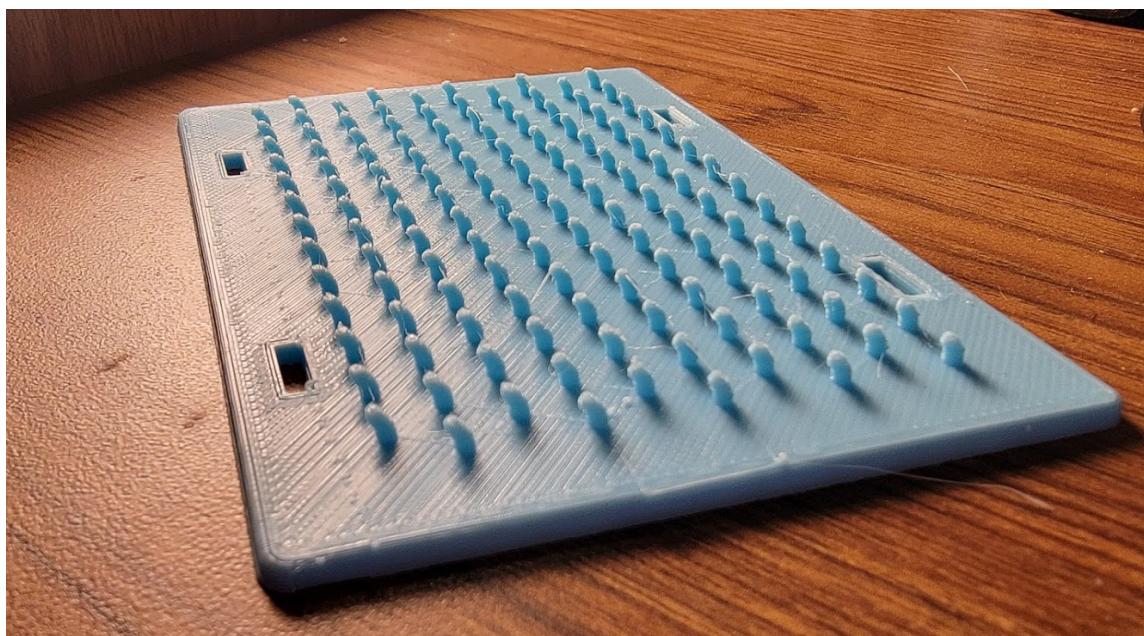


Figure C2: Final Bristles



Figure C3: First Bristle Prototype

Appendix D: Group Responsibilities

DD1: Project Management			
Project Manager for Assignment	Angelina Barone		
Deputy Manager for Assignment	Mira Faizul		
Drafted Assignment	All group members	Revised Assignment	All group members
Reviewed Assignment	All group members	Proofread Assignment	All group members
Created Figures	Dan Haikal	Created Tables	Ranga Rutiser Sundar
Other Contributions			
N/A			
Problems Overcome			
The group was able to make a complete schedule to finish the prototype and testing phase on time.			

DD2: User Validation Plan			
Project Manager for Assignment	Mira Faizul		
Deputy Manager for Assignment	Dan Haikal		
Drafted Assignment	All group members	Revised Assignment	All group members
Reviewed Assignment	All group members	Proofread Assignment	All group members
Created Figures	Angelina Barone	Created Tables	Ranga Rutiser Sundar
Other Contributions			
N/A			
Problems Overcome			
The group created a plan to validate the prototype and evaluate how well it meets user needs.			

DD3: Social and Economic Value			
Project Manager for Assignment	Ranga Rutiser Sundar		
Deputy Manager for Assignment	Mira Faizul		
Drafted Assignment	All group members	Revised Assignment	All group members
Reviewed Assignment	All group members	Proofread Assignment	All group members
Created Figures	Angelina Barone	Created Tables	Dan Haikal
Other Contributions			
N/A			
Problems Overcome			
The group defined the values the product delivers for various stakeholders and addressed the impacts of the group's solutions.			

DD4: Detailed Design			
Project Manager for Assignment	Dan Haikal		
Deputy Manager for Assignment	Angelina Barone		
Drafted Assignment	All group members	Revised Assignment	All group members
Reviewed Assignment	All group members	Proofread Assignment	All group members
Created Figures	Mira Faizul	Created Tables	Ranga Rutiser Sundar
Other Contributions			
N/A			
Problems Overcome			
The group described the full process of prototyping including the testing and verification.			