Applicomb:
An applicator comb for dry scalp & dandruff

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Client:
Dr. Ruchi Gupta, Northwestern University Feinberg School of Medicine/ Ann & Robert H. Lurie Children's Hospital of Chicago

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Executive Summary

Through consultation with Dr. Ruchi Gupta, a practicing physician at Northwestern University's Ann & Robert H. Lurie Hospital of Chicago, we designed an applicator comb that would allow users to apply dandruff/dry scalp treatment to their scalps while brushing their hair.

Due to the remote nature of this course, most of our consultation with Dr. Gupta and other key experts were held virtually. We held virtual conference calls with Dr. Gupta to gain more insight into key specifications and requirements about the design project. We also consulted with Carl Traynor, an advisor for the commercialization for Dr. Gupta's treatment, and Dr. Lio, who worked on the development of the product, for additional insight and suggestions. We noted the shortcomings of current products and issues Dr. Gupta hoped to address, along with interviewing key experts and Dr. Gupta on the issues they found. We then designed various mockups which we cross referenced with each other to compare effectiveness and efficiency. We also discussed these prototypes with our classmates and DTC professors in order to determine the benefits and drawbacks of these various features. From this, we ultimately designed and created our prototype.

The Applicomb is the ideal product for patients looking to apply dry scalp/dandruff treatment without wasting product in their hair. It is roughly the same size as a standard hair brush, with a shape comparable to that of a standard flashlight. It can easily be filled with solution and combed through the hair to evenly dispense Dr. Gupta's solution. The Applicomb fulfills the client's requirements of waste reduction, safety and comfort, and reusability.

- **Waste Reduction:** The Applicomb's nozzles are designed to target treatment directly to the scalp while combing through the hair; the amount of the treatment dispensed is controlled by the user and the treatment is no longer prone to sticking to hair.
- **Safety and Comfort**: The Applicomb has an ergonomic design to provide the user with a better grip and greater comfort. The plastics used for construction are soft and will not irritate or damage the skin.
- **Reusability:** The Applicomb consists of three detachable components, each of which can be rinsed with soap and water to ensure long-term usage. The plastics used for construction are also durable and will not easily wear down.

The Applicomb is the most efficient, comfortable, safe, and reusable option for patients looking to apply dandruff treatment to their scalp without hassle or trouble.

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Introduction

Dry scalp and dandruff is a common condition that affects many individuals across the country. Practicing physician at Northwestern University's Ann & Robert H. Lurie Hospital of Chicago, Dr. Ruchi Gupta, along with a team of specialists, has worked to create a topical treatment for dry scalp symptoms made from natural ingredients such as yogurt and honey. To use the treatment, every morning patients use their fingers to part their hair and apply the treatment to their scalp, where it stays for seven minutes before the individual rinses it off. Multiple users--especially those with thicker and longer hair--waste a significant amount of time and treatment as it gets stuck in their hair and does not actually penetrate the scalp. Therefore, Dr. Gupta tasked us with designing a product to solve this problem.

Throughout this design process, our mission was to design an efficient, safe, and reusable applicator device that applies medicinal treatment directly to the scalp with minimal waste (Appendix A: Project Definition). This allows for an easier and quicker morning routine that ultimately saves the user time and money.

Our final product,the Applicomb, meets these goals and solves the issues outlined above with its ergonomic design. The product features a curved body, similar to the brush handle, that serves as the handle and the reservoir for the treatment; a row of nozzles that are sturdy enough to dispense the viscous treatment, but soft enough not to cause any irritation to the scalp; and a cap for storage. The user can use the Applicomb with one hand to quickly comb the treatment through their hair with complete coverage. This product is simple, making the process less tedious and more effective in ensuring that the product is truly reaching the scalp.

This report outlines the users and requirements of our product, its overall concept, the research and rationale behind our design, and ideas for the future development of our product.

Users and Major Requirements

Throughout the design process we have been in close communication with our project partner, Dr. Ruchi Gupta, and her colleagues, who in some cases have experience with both the production of the treatment and the tedious nature of applying the treatment by hand. Working with this array of professionals allowed us to use their expertise and gain valuable insight on how to best accomplish our mission. In addition to working with experts and first-hand users, we gathered information about hair from the general population to better understand how to fulfill the needs of a potential user.

Main Users of the Product

Dr. Ruchi Gupta

Although not a direct user, as a physician and one of the main creators of the dry scalp/dandruff treatment, Dr. Gupta will be utilizing our product on her patients and must have a thorough understanding of the functionality and ease of our product.

Users of Dr. Gupta's Treatment

While the current patients of Dr. Gupta's study for the dry scalp/dandruff treatment will be the most immediate main users of our design, future users of Dr. Gupta's treatment are also the target audience of our product. This base of users could expand to the general population of adults receiving treatment for dry scalp. When designing our product, we sent out general surveys (See Appendix B: General Survey Results) to help ensure that our product is viable for all age, race, and gender groups and a wide range of hair demographics.

Requirements

Waste Reduction

The main issue with the current method of applying treatment to the hair is that there is an increased risk of getting the thick treatment stuck in the hair and thus using more treatment than is necessary. By using a series of nozzles, the Applicomb is designed to target treatment directly to the scalp while combing through the hair. The amount of the treatment dispensed is controlled by the user and the treatment is no longer prone to sticking to hair.

Safety and Comfort

Individuals with dry scalp and dandruff may have a sensitive scalp; therefore it was imperative that our product--particularly the nozzles--be as comfortable as possible as to not cause abrasions on the scalp (Appendix C: Expert Interview Summary. In addition, the product must also be comfortable and easy to hold. Consultation with Carl Traynor (Appendix D: User Observation Summary) emphasized the need for an ergonomic design of the body to provide the user a better

grip. Unfortunately, we were unable to perform testing on users to determine a true rating of comfort.

Reusability

Since this product is intended for daily use, the device must not break or deteriorate quickly after continued use and should be able to be washed to prevent buildup of old treatment. Moreover, Dr. Gupta emphasized the need to have a product that can be reused, similar to the reusability of a standard razor (Appendix E: Client Interview Summary). Although we cannot test how long Applicomb will last, we made the product into three separate pieces so that each can be thoroughly cleaned by the user.

Design Concept and Rationale

This section will show the design decisions made and explain the rationale behind the decisions, especially how the design meets the goals set by the team (Appendix A: Project Definition). The design of the Applicomb is meant to allow the easy distribution of Dr. Gupta's scalp treatment. The users with the most difficulty are those with thick and long hair, so the design is more catered to that demographic, but anyone will be able to use the Applicomb (Appendix E: Client Interview Summary). The design consists of a base, screw on nozzles, and a cap for the nozzles. To use the applicomb, one squeezes the bottle in one hand while moving the nozzle through the hair like a comb, thus distributing the treatment evenly throughout the scalp (Appendix F: Instructions for Use).

Body

Specifications

The body is a 4.1 inch tall contoured bottle. Figure 1 is a detailed Computer Assisted Design (CAD) drawing of the body. At the bottom it is widest with a diameter of 2 inches, and thinnest at a height of 1.75 inches with a diameter of 1.8 inches. As the height continues the bottle gets wider again up for an inch until it is 1.83 inches wide in diameter. At the height of 3.5 inches there is a .3 inch tall shoulder, which transitions to a .3 inch tall neck and finish. The mouth has a diameter of 1.23 inches. The body is .1 of an inch thick.

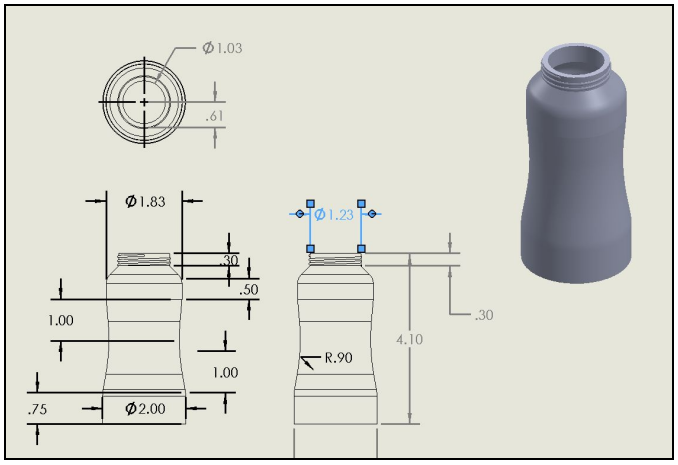

Figure 1. CAD drawing of the body.

Rationale

The main functionalities of the body are to both act as the handle to the Applicomb and as a reservoir of the treatment. The shape of the body is meant to be user friendly and to fit in comfortably in the hand. Originally, the body was going to be a cylinder, but it was later decided that the shape would be more contoured to allow an easier grip (Appendix G: Design Review Summary). The size and volume of the Applicomb is meant to contain a sufficient amount of treatment, more than what is supplied each month. That way, the Applicomb can be used on a daily basis and refilled when a new shipment of the treatment arrives, and if there is any left

over, the new supply can be added upon the remains of the previous month without a risk of overflow. A 4-inch height is similar to the handles of combs, so it will be an easy substitute for day to day use. The material for the body would be a low density polyethylene, which is used in similar squeezing products, allowing the functionality desired from the Applicomb, while also being very cheap to allow for mass production (Appendix H: Bill of Materials).

Nozzles

Specifications

Early research showed several existing products that serve the purpose of using comb-like teeth to apply some liquid to the scalp, using that for inspiration allowed the creation of the nozzles (Appendix I: Background Research). The nozzles are how the treatment will reach the scalp, without irritating further or getting stuck in the hair. Figure 2 showcases a CAD rendered drawing of the nozzles. The nozzles will be able to be screwed onto the body. The main cylinder is .6 inches tall and 1.84 inches wide, while there is a .1 inch tall platform where the nozzles rest. There are 7 nozzles, 4 mm in diameter at the base and 3 mm in diameter at the top and are 2.5 cm tall. Each nozzle is .1 inches apart from each other at the base.

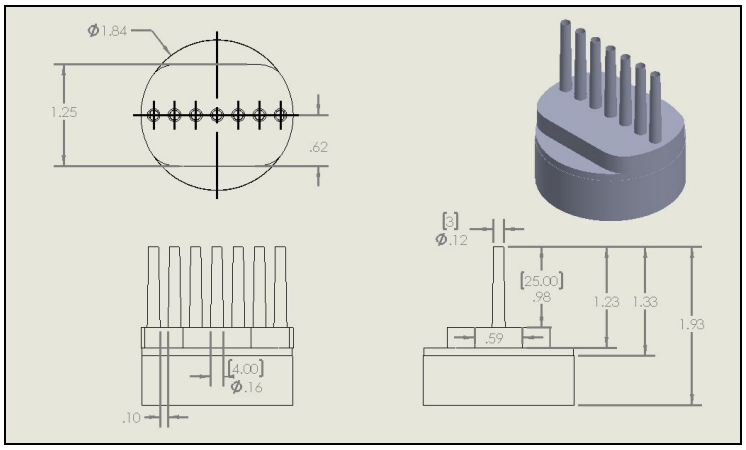

Figure 2. CAD drawing of the nozzles

Rationale

The sizing allows it to be easily attached to the body using a screw on system, so it can be removed for cleaning and refilling, aiding in the reusability of the Applicomb. The nozzles, which will act similar to the teeth of a comb, have holes that will excrete the treatment. Testing showed that the shorter distance a viscous material travels, the less forces is needed to push out the viscous material. This led to the needles being 2.5 cm long, which is shorter than what was tested to ensure low difficulty. It also showed that honey, a material similar in viscosity to the treatment, can come out of a hole 2 mm in diameter (Appendix J: Mockup Testing Summary). The length of the needles and diameter of the holes ensure that the viscosity of the treatment will not be a problem when using the Applicomb. The material of the nozzles will be polypropylene, a soft rubbery plastic that will be both cheap and soft so as to not scratch the scalp (Appendix G: Design Review Summary).

Cap

Specifications

The cap is relatively simple, it is slightly over 1 inch in height. The base is in the shape of an elliptic cylinder that is .2 inches wide and .2 inches thick. The elliptic cylinder spreads to be a circle that is 2 inches in diameter. Figure 3 illustrates the cap.

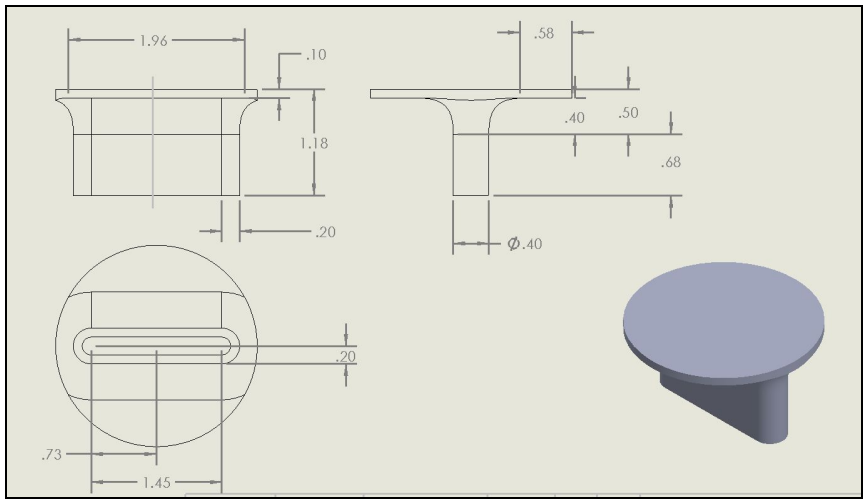

Figure 3. CAD drawing of the cap

Rationale

The need for a cap was brought into light for a technical reason, to prevent the treatment drying from the air. However, drying will not be an issue, but Dr. Gupta requested one to be designed for practical use to prevent spilling and allow safer storage. The design of the cap is to be easily attached and detached, covering the nozzles only. The bottom of the cap is in line with the nozzles, so orientation will not be difficult. The top is circular to allow an easy grip to remove the cap, and also acts as a base so the Applicomb can be stored upside down. That way, the treatment will already be at the nozzles, allowing a quicker application of the treatment. The material for the cap will also be a low density polyethylene, as it is cheap and easily mass produced through injection molding (Appendix G: Design Review Summary).

Future Development

There are various adaptations we believe would improve future iterations of the product. In order to reduce cost and increase ease of use, it may be beneficial to modify the nozzles to screw onto the solution bottle, rather than the body of our current design. This would reduce cost by decreasing the number of parts required. It would also increase ease of use, requiring only that the user screw the nozzles onto the solution container, rather than first transferring the solution into the body. Furthermore, it may prove beneficial to design variants of the body with different sizes. Users may prefer different amounts of solution depending on how much they require, making different body sizes ideal as it would allow them a greater degree of customization. Lastly, per Dr. Gupta's approval, it may be advantageous to brand the Applicomb product. This may make the product more friendly and appealing — an important consideration for skincare products like the Applicomb.

Conclusion

The Applicomb is a result of several weeks of research, brainstorming, testing, and analysis. It's design not only meets the criteria set upon by Dr. Gupta, but also fulfills all the goals the design team imposed. The nozzle and reservoir allows the treatment to reach the user's scalp without any treatment getting stuck in the hair, significantly reducing wasted treatment. The shape and size of the nozzles accounts for the viscosity of the treatment. The material of the nozzles are soft for the scalp, and the entirety of it will be cheap to produce in mass. The screw on design of the nozzles allow it to be refillable and replaceable if the need rises. It can also be cleaned to aid to be a long term solution. The Applicomb has potential to be used by anyone with all hair types. It can be incorporated into one's daily routine and is intuitive to use becoming a must have for all users of Dr. Gupta's treatment for the most efficiency.

References

Lio, Peter. Personal interview. May 8, 2020

Traynor, Carl. Personal interview. May 7, 2020.

Gupta, Ruchi. Personal interview with Jain, T. April 14, 2020.

Yarbough, C. (1999) Hair colorant applicator comb and method. US Patent ID: US6260557B1.

Washington, DC: US Patent and Trademark Office

Appendix A: Project Definition

Project Name: Scalp Applicator Comb

Client: Dr. Ruchi Gupta, Northwestern University Feinberg School of Medicine

Team Members: Michael Vega, Crockett Callaway, Katherine Brown, and Ankhaa Enkhmandakh

Date: April 23, 2020

Version: 2.0

Mission Statement
Our mission is to effectively and collaboratively design a more efficient applicator for dry scalp treatment. This comb should be one-handed, be able to apply the treatment directly to the dry scalp, as well as minimize excess treatment wasted.

Project Deliverables
These items are to be delivered to the client at the end of the quarter:

- A presentation explaining decisions behind the design.
- A final report.

Constraints
There are a number of restraints, coming from the nature of the class and the current global pandemic, these include:

- A communication constraint allowing only meeting with team members and professors via the internet.
- A physical restraint preventing team members from using the Ford Design Center for building a final product.
- A $100 budget constraint.
- A due date for the deliverable of June 8th, 2020.

Users and Stakeholders
The primary stakeholder for this design project is Dr. Gupta. She presented the problem her participants were having when applying their dry scalp/dandruff treatment and provided the communication for us to gather information about the users. Our secondary stakeholders are the past and future participants of Dr. Gupta's treatment.

User Profile

The users of this product are adults who have a dry scalp or dandruff who are searching for a treatment method. Currently the product is in testing stages, and users with longer, thicker or curlier hair have had difficulty applying the product as it gets stuck in their hair.

User Scenario

In a hypothetical situation, a female user with long thick hair is attempting to apply the product to the entirety of her scalp using her hands. The product is very thick and sticky, so when she tries, a majority of the product gets stuck in her hair. This causes her to take at least 5 minutes to cover her scalp. After 7 minutes of letting the product rest, she takes a shower and washes the product out.

Needs Identification, Metrics, and Specifications

Table 1. Needs Specifications

Category	Needs	Metrics
Waste	Reduce the amount of product wasted.	Percent of product wasted
Scalp Safety	Not any irritation to the scalp.	Sharpness
Comfort	Be easy for the user to use without getting tired.	Scale of Difficulty
Variety	Have different lengths for different hairs.	Number of designs or adaptability of singular design

Appendix B: General Survey Results

Notable Trends:

1. The majority of those surveyed (50 in total) reported the following types of hair:

- 51.4% of all users reported thick hair
- 60% of all users reported curly hair
- 48.6% of all users reported medium/average length hair

2. Users preferred the following mediums for applying hair treatment:

- 68.6% preferred using their hands
- 20% preferred using a dropper
- 5.7% preferred using a comb

3. When asked about which method of application sounded ideal, users said:

- 37.1% preferred the applicator comb
- 37.1% preferred the dropper
- 25.7% preferred using hands
- None (0.0%) preferred the brush

Insights:

1. *This trend allows us to arrive at the following conclusions:*
    - The final design would ideally be a comb, rather than brush
        - The majority of users (60%) reported curly hair, which often becomes frizzy and damaged when brushed; a comb does not have as damaging of an effect on curly hair
    - We should incorporate the ergonomic aspect of a brush into our comb design
        - There is still value in a brush's ergonomic design, so this is something we may be able to harness in our final comb design.

2. *This trend allows us to arrive at the following conclusions:*
    - While using hands would defeat the purpose of this design project, it is evident that the dropper-system is a viable solution to this problem
        - Users would feel comfortable using a dropper-system in conjunction with a comb
    - Only 5.7% of users currently use a brush, which tells us that it may be difficult to attract users with a brush-design when they do not currently use a brush
3. *This trend allows us to arrive at the following conclusions:*
    - 74.2% of users prefer an applicator comb and dropper, which confirms our design idea of having an squeezable applicator compartment below the comb itself
    - Because 0.0% of users surveyed thought a brush was best, it is safe to assume this is not an ideal design for the product

4. *This trend allows us to arrive at the following conclusions:*
    - Most users find their hands ideal for putting in product
    - This allows us to model our comb after the user's hand?

Appendix C: Expert Interview Summary

Brief

On Friday, May 8, 2020 at 4:30 PM CDT , a Zoom meeting was conducted with Dr. Peter A. Lio, a dermatologist and clinical assistant professor of Dermatology and Pediatrics working with Dr. Ruchi Gupta to create a treatment for dry scalp and dandruff. Katherine Brown conducted the interview and took notes. The team hoped to gain information about the dermatological side of the project and to understand what additional precautions or requirements need to be considered when designing the solution. Our ultimate goal was to obtain information that would allow us to adapt our design accordingly.

Background

Dr. Lio worked on the development of the product. He approved of our comparison of the product to honey, stating that the product was made using honey and yogurt. Dr. Lio reiterated that the product is challenging to work with, sticking to both the hands and hair. He also recommended that we search Google Patents for similar products and look to Amazon for design ideas.

Scalp Care

Dermatologically, the solution should not cut or irritate the scalp. Dr. Lio pointed out how dermatology is approachable by anyone — if one person can do it, so can the user. In designing the product, Dr. Lio recommended that we:

- Do not use metal for the material of the comb.
- Consider coating the tip of the silicone, which may actually prove to be very expensive.
- Have rounded tips to ensure scalp damage cannot occur.

Design Considerations

Dr. Lio raised several questions that should be answered in designing the final solution, including:

- How do we ensure the product does not get clogged?
- How do we cover a large area of the scalp quickly?
- How far apart should the teeth be spaced in order to ensure proper application of product?
- How long should the teeth be?
- How many rows should it have?

Feedback

Dr. Lio gave some feedback to the following designs:

Design 1: Applicator Comb (Tube Shaped)

- Dr. Lio noted he:
    - Likes the base design.
    - Thinks it might be too long and would prefer a square shape.
    - Would like multiple rows.

Design 2: Applicator Comb (Vertical Teeth)

- Dr. Lio noted he:
    - Thinks it might be too weak and might break.

Design 3: Applicator Comb (Tube Shaped) with Syringe

- Dr. Lio noted he:
    - Thinks it would be tough to market.
    - Believes users are not as likely to want a syringe near their scalp.

Summary

From a dermatological standpoint, there are very few limitations to consider when designing the final product. The largest limitation, which we addressed through our honey-dropper test, was the viscosity of the product and how it might flow through our applicator comb. This interview allowed us to conclude that the biggest concern is scratching the user's scalp, which might be prevented by using rounded tips and a softer material (silicon, viton, natural rubbers, etc). However, Dr. Lio presented several design elements to acknowledge, such as marketability, clogging and structure. On the marketability front, Dr. Lio argued it might be difficult for users to feel comfortable using a syringe-style design near the scalp. Because this was unqualified, we aim to cross-reference this claim using data collected from our User Interview with Carl Traynor. Lastly, we hope to address Dr. Lio's concerns regarding clogging and structure by analyzing the proper tube diameter for the system and by finding a soft material for the end of the applicator.

Appendix D: User Observation Summary

Brief

Michael Vega, Katherine Brown, Ankhaa Enkhmandakh, and Crocket Callaway met with Carl Traynor to gather remarks and feedback on various applicator comb models. Mr. Traynor is an advisor for the commercialization for Dr. Gupta's treatment, and has a vested interest in the success of the product when it enters the market. The purpose of this session was to get a more direct assessment of the models we have created as well as gather comments on future development. The session lasted 40 minutes. This appendix explains the methodology used to conduct observation, the feedback given throughout the meeting, and summarizes the results of the observation.

Methodology

The session took place on a Zoom call on Thursday, May 7, 2020, at 5 PM CST. Due to the quarantine, a zoom call allowed us to have a close replacement to a face-to-face meeting. We began by asking Mr. Traynor what he was looking for in the final design. Following this, we showed him the current applicator comb design models. He was asked about the effectiveness of these designs and how he thinks users would react to them. Finally, he was asked about any potential concerns to take into consideration when finalizing a model.

User Information

Carl Traynor is an advisor on the commercial side of topical treatment and a user of the treatment. Since the current application method is using hands to rub the scalp, he expressed the need for an efficient applicator comb.

User Observations

The first model that Mr. Traynor observed was the Comb and Reservoir seen in Figure 1.

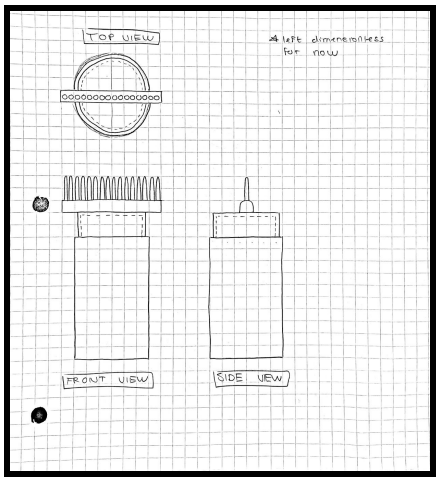

Figure 1. Comb and Reservoir Model

Immediately after being shown this model, Mr. Traynor recognized a possible error with the flow of treatment. He explained that having too many teeth could create a necessary force too strong for an everyday user. Also, he mentioned a design revision to improve the model's movement as it flows through the hair. He proposed that the teeth of comb have a length similar to that of the treatment reservoir. Finally, he stated that the design has promise but could use some changes to maximize its user utility.

The second model observed was the Vertical Comb with handle seen in Figure 2.

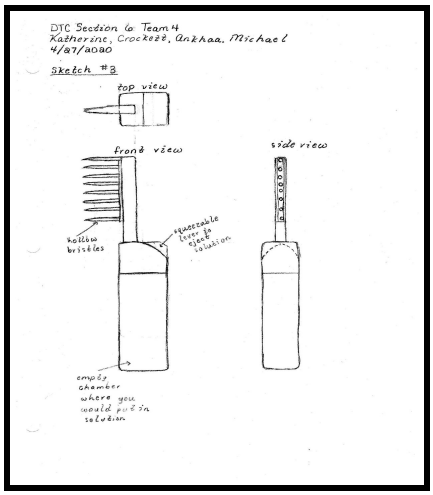

Figure 2. Vertical Comb with Handle

The initial remark expressed was Mr. Traynor's appreciation for the design. He felt that this model has a more natural feel, similar to a brush. Similar to the first model, he was hesitant about whether or not the treatment would be able to flow down the ends of the teeth without excessive force being necessary. A possible solution presented would be allowing some of the treatment reservoir to be located up the comb.

The final model observed was the Syringe Treatment method seen in Figure 3.

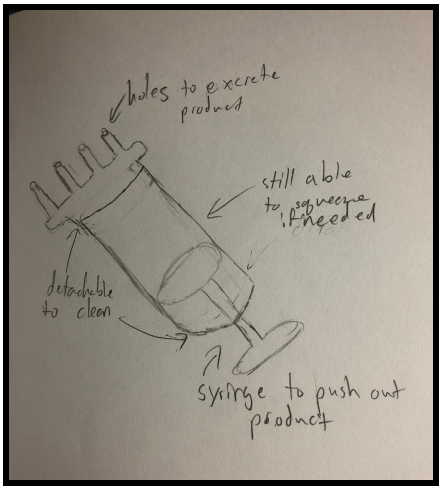

Figure 3. Syringe Treatment method

Mr. Taynor did not feel this model was as viable as the other two shown earlier in the meeting. He explained that this is an effective applicator but not an effective applicator comb. The treatment needs to flow through the hair to cover the entirety of the scalp, so design revisions would be necessary to fit the criteria of the final design. A viable change to increase the efficiency of this model would have a variation of teeth to mimic a comb.

Appendix E: Client Interview Summary

Brief

In an online Meeting using Zoom, a client interview was conducted with Dr. Ruchi Gupta and Dr. Tarun Jain on Tuesday, April 14th, 2020. Ankhaa Enkhmandakh, Katherine Brown and Michael Vega were present, as well as Professor Carr. The purpose of the interview was to learn in detail about Dr. Gupta's product for dandruff treatment. The team wanted to learn what the issues have been with applying the product, who has been having the issues, and any other vital info

Product

The product is a topical treatment that is meant to be applied directly to the scalp, left on for about 7 minutes and then washed off in a shower. The product is:

- Semi-viscous, akin to warm honey or a thick conditioner.
- Meant to be used as a face mask for the scalp.
- Meant to be resupplied every month.
- Meant to be applied to a dry scalp and dry hair.

Users

There is a large variety of users; however, women with longer hair have more difficulty. What has been gained from users include that:

- The majority of users have no issues whatsoever.
- They are currently using their fingers for application.
- Women typically ran out of product in half the time of men.
    - The product would get stuck in their hair.
- The thicker the hair, the more product wasted.
- It is possible to get out a survey to those who tested the product.
- Application onto animals such as dogs should be taken into consideration as well.

Requirement/Needs

Dr. Gupta specified some requirements and desires for a hypothetical solution, it should:

- Ideally have multiple designs meant for people with different types of hair.
- Not use latex due to allergies.
- Have a lifetime of at least a month
- Not agitate the scalp and ideally it would feel good to use on the scalp.

Possible Solutions

When discussing possible solutions came up, some ideas include:

- Diluting the product, which would make the product runny and impair the user experience.

- An applicator comb would be an agreeable solution.
    - It cannot be too sharp as it would agitate the skin.
- Lightly spraying hair with water to make the product easier to apply.
- An item similar to hair dye applicators, which are easy to use, but potentially harmful to the scalp

Summary

Overall, there are very few restrictions to solutions for the product. Only those with longer and thicker hair have issues with product getting wasted in the hair. They prefer to not alter the state of the product and would like a solution to the current state, but would be open to it if needed. A brush or comb that could apply the product without agitating the scalp seems to be the preferred solution from Dr. Gupta as long as they do not agitate the scalp. A survey for those who tested the product needs to be approved by the Institutional Review Board, and it could take 2 weeks to get the survey to users. Dr. Gupta has provided contact information for individuals who would be beneficial to interview, including a user with long hair, a dermatologist, a veterinarian, and another doctor working on the product. Dr. Gupta is willing to test current products on the market and provide information on how well it works.

Appendix F: Instructions For Use

Instructions for Using the Applicomb

The following are the steps to follow when using the Applicomb, this includes how to fill the Applicomb, how to apply the treatment, and how to store the Applicomb.

Initial Set Up (Also can be followed when refilling)

1. Unscrew the nozzles from the body of the Applicomb.
2. Take the treatment (supplied separately) and insert into the body of the Applicomb.
3. Screw the nozzles back onto the body of the applicomb.

Usage

1. Take the cap off the nozzles.
2. Put the tip of the nozzles to the hairline.
3. Run the Applicomb through the hair, like a hair clipper and squeeze gently to push out the treatment.
4. Repeat the process until the scalp has been covered.
5. Put the cap back on the nozzles.
6. Store the Applicomb for later use.
7. (Optional) Put the Applicomb upside down so the treatment is already in the nozzles.

Appendix G: Design Review Summary

Date: 5/19/2020
Time: 11:30 AM to 12:00 PM
Team members in attendance: Katherine, Crockett, Ankhaa, Michael
Other key attendees: Professor Carr, Professor Casler, Scott Simpson

Introduction: The purpose of this design review was to hear feedback on our design, which will help us decide what should be kept as is and what should be revised before the final design is decided upon. It was conducted remotely using Zoom.

Table 1: Feedback from Design Review

Design Attribute (component, feature, etc.)	**Comments**
Material	Reservoir: Low Density Polyethene would be extremely cheap and is a material that has been used for similar products. Nozzles: Thermoplastic Elastomers would be a softer material that would feel better on the head.
Production	3D printing could work for creating a mockup, but for mass production injection molding would be most efficient and cost effective.
Nozzles	Rubber or silicone tips on the nozzles would allow the nozzles to easily be pressed up against the scalp without irritation. However, the material would be very expensive and would not be possible to injection mold.
Reservoir Size and Shape	The shape of the reservoir might not be comfortable for everyone to use.
Drying	A possible problem can be that the treatment would dry out from exposure to air.

Follow-up: All of the feedback has been taken into account and consideration. The material and production comments will be especially useful. There will be further research to see if nozzle tips would be necessary and worth the cost, as well as to improve upon the shape and size of the reservoir. In order to provide a solution to the possible drying issue, a cap will also be designed to prevent drying as well as accidental spills.

Appendix H: Bill of Materials

This bill of materials is an estimate of costs to mass produce the product, which includes the cost to purchase the equipment needed for manufacturing. The marginal price will drop as the amount of Applicomb is produced. The prices are estimations from an expert in materials and production, Professor Carr.

Table 1: Bill of Materials

Item	Description	Qty	Vendor	Part number	Unit cost	Total Cost
Low Density Polyethene	A low density plastic ideal for the durability required of the body and cap of the comb	n	N/A	N/A	$0.50	$0.50 * n
Polypropylene	A plastic ideal for the durability required of the nozzles.	n	N/A	N/A	$0.30	$0.30 * n
Injection Molding	Used for shaping the pieces. Would be a one time purchase.	1	N/A	N/A	~$10,000	~$10,000

2,381 would need to be produced for **$5.00** per product.
5,883 would need to be produced for **$2.50** per product.
50,000 would need to be produced for **$1.00** per product.

Appendix I: Background Research

Client Interview

- Client: Dr. Ruchi Gupta
    - Director, Institute for Public Health and Medicine (IPHAM) - Center for Food Allergy & Asthma
    - Professor of Pediatrics (Academic General Pediatrics and Primary Care) and Medicine
    - Regarding clinical care, Dr. Gupta has published strategies to improve primary care management of both food allergy and asthma. Within the area of community health, she and her team have published some of the largest studies on quality of life in food allergy as well as on labeling, risk-taking and school policies of epinephrine. She has also developed and published data on school programs to empower students with asthma to improve their management and educate their communities.
- Organization: Northwestern University Feinberg School of Medicine/ Ann & Robert H. Lurie Children's Hospital of Chicago
    - Top 10 Children's Hospital in the country
    - Stanley Manne Children's Research Institute

Competitive / Model Products

There are a number of existing similar products to the ideal product specified by Dr. Ruchi Gupta. Dr. Gupta has stated he is looking for something that is able to be used as an applicator comb, rather than merely a scalp shampoo brush which is generally used for when the hair is wet or to massage the scalp. We identified the following as similar competitive or model products:

- Just For Men Easy Comb-In Color
- L'Oreal Paris Magic Root Rescue

Just For Men Easy Comb-In Color

The Just For Men Easy Comb-In Color is a device that allows the user to cover up dull or gray hairs using a simple screw-in applicator tube to a small comb. Just For Men, the parent company of the device, recommends the user to apply the comb and hair color tube to dry hair — the exact hair state specified by Dr. Gupta. Although this device is not used for treating dry scalp, the functionality of the product is very similar to the desired functionality of Dr. Gupta's product.

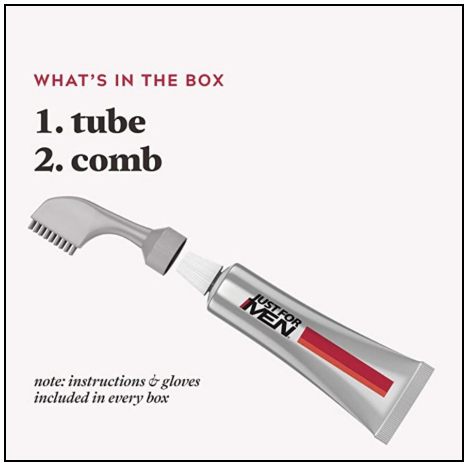

Figure 1: Basic Components of Just For Men Easy Comb-In Color
Source: Amazon.com
<https://www.amazon.com/Just-Men-AutoStop-Color-Black/dp/B006ZR8VWG/ref=sr_1_4?dchild=1&keywords=hair+dye+comb&qid=1586843867&sr=8-4>

L'Oreal Paris Magic Root Rescue

The L'Oreal Paris Magic Root Rescue product, much like the Just For Men Easy Comb-In Color, allows the user to cover up gray or dull hairs. It is a hair-coloring product primarily, however it's applications could be extended to the haircare and hair-wellness industry in general. It is not a direct competitor, however the device's general functionality should serve as reference for potential prototypes for Dr. Gupta's Product.

Figure 2: Components of L'Oreal Paris Magic Root Rescue
Source: L'Oreal
<https://www.lorealparisusa.com/products/hair-color/products/root-touch-up/magic-root-root-rescue-10-minute-root-hair-coloring-kit.aspx?shade=7-dark-blonde>

Existing Patents

As of now, there are not any patents that directly utilize an applicator comb for dry scalp treatment; however, there are many patents that match the requirements Dr. Gupta has enlisted for different purposes. The ideal device described by Dr. Gupta would be an applicator comb that would apply scalp treatment directly to the scalp regardless of hair type or length. We have identified a patent that we believe would assist with our design process.

Hair colorant applicator comb and method

This hair colorant applicator comb utilizes a hollow body to allow for the flow of colorant, a cylindrical upper that holds the colorant, and hollow tubes in the teeth of the comb for the colorant to flow from the applicator comb directly to the scalp. Although the main use of this product, as described in the patent, is for hair colorant, we believe that this would be equally effective at applying a scalp treatment. The tubes in the teeth of the comb allow for easy flow of a liquid from the comb to the user's desired location, which would meet Dr. Gupta's need to minimize wasted treatment. Altogether, this design provides insight into a solution for our problem that would be efficient as well as provide an easy application method for users.

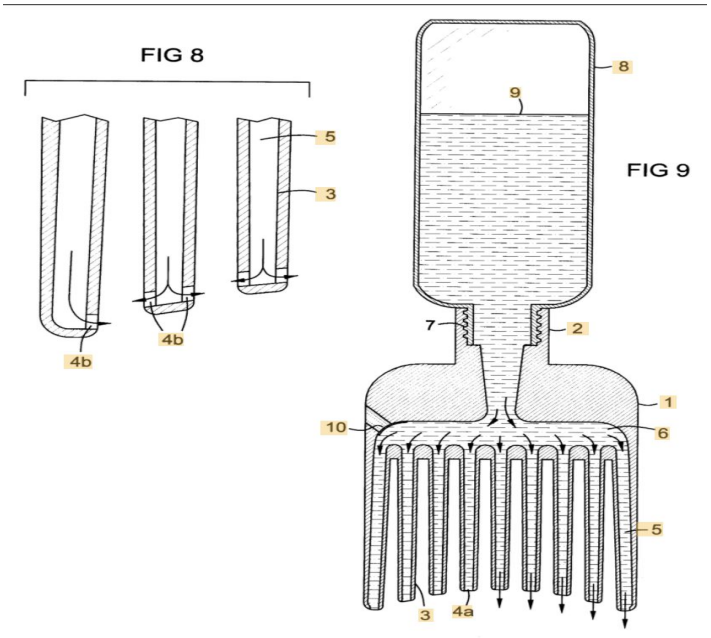

Figure 3: 1999 Hair colorant applicator comb and method
Patent filed by Christine Yarbough
Patent ID: US6260557B1

Appendix J: Mock-Up Testing

Experiment 1: Eye Dropper

Table 1. Honey Test

Dropper	Diameter of Dropper	Length of Dropper	Force Needed	Observations
1	0.2 cm	11 cm	A medium amount of force needed	- When the tube is completely full of honey, it is easy to dispense but when the tube is only about a quarter full of honey it is harder to dispense because the honey has to move down the entire length of the tube - Flows easily from the diameter of the dropper
2	0.2 cm	7.5 cm	Minimal amount of force needed	-Since the tube is shorter it does not require as much force to push honey through the length of the tube - An even shorter tube would require even less force

Table 2. Thick Conditioner Test

Dropper	Diameter of Dropper	Length of Dropper	Force Needed	Observations
1	0.2 cm	11 cm	Extensive amount of force needed	- It is difficult to put conditioner into the tube, so the tube was only partially filled - It is quite difficult to squeeze conditioner through the total length of the tube - The size of the opening makes the dispensing of the conditioner very slow and not a continuous flow

2	0.2 cm	7.5 cm	Slightly less force needed	- The size of the opening is bit too small for the viscous conditioner (it would be easier if is was watered down) - Despite this being a shorter tube, it is still difficult (albeit slightly less) to push conditioner through the tube

Experiment 2: Syringe

Table 3. Honey Test

Syringe	Diameter of Syringe Aperture	Length of Syringe	Force Needed	Observations
1	0.1 cm	8.5 cm	Extensive force (too much force is needed)	- This syringe was a medical syringe - The honey was dispensed very slowly (drop by drop); the opening is way too small to be plausible

Table 4. Conditioner Test

Syringe	Diameter of Syringe Aperture	Length of Syringe	Force Needed	Observations
1	0.1 cm	8.5 cm	Extensive force (too much force is needed)	- This syringe was a medical syringe - Almost no conditioner came out, the opening is definitely too small - Also something this small would be difficult to clean