Breathe Beauty

Varahunan Mathiyalakan, Patricia Kolodziejski, David Sheng, Harold Treminio

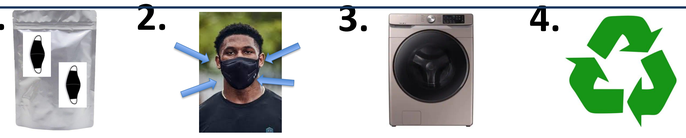
Johns Hopkins University | Whiting School of Engineering | Baltimore, MD
Design Day 2022

Introduction

Imagine this -- it's been a long day of class. Rushing from Process Design in Hodson to Product Design in Bloomberg for the last 8 hours, you finally take off your mask only to be horrified to see what's happened to your skin.

According to the Mayo Clinic, prolonged mask-wearing creates "excess moisture that [leads to] skin irritation on the nasal bridge, chin, and or cheeks." This situation is all too common for young adults who juggle the dilemma of abiding by public health measures while keeping good health.

How Does It Work?



1. BUY IT

Our product comes in packs of 2

2. WEAR IT

Wear the mask normally, watching Vitamin E release at the arrow locations

3. WASH IT

Our product can withstand 3-4 washes!

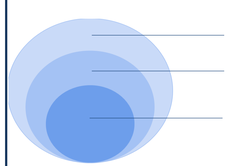
4. RECYCLE IT

All parts are biodegradable

Market & Challenges

Skin Care Products Market

Non-Luxury Facial Skin Care



TAM: US Facial Skin Care Market ($14B, 210 M people)

SAM: US Consumers Ages 18-34 Using Moisturizer Cream 14x a week ($2.1B, 25M people)

SOM: 5% Adoption Rate ($105 M, 1.25 people)

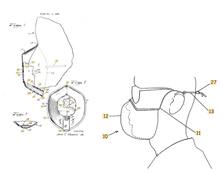
Competition

Primary *(Cosmetic Masks)*: Estée Lauder Companies, Unilever, L'Oréal

Secondary *(Other Facial Cosmetic Products)*: Estée Lauder Companies, Unilever, L'Oréal

Tertiary *(Typical Face Masks)*: 3M, Honeywell

IP Challenges



No current active patents on this concept, many in development

Regulatory Challenges

FDA

Must abide by FDA Mask Standards:

Bacterial/Particulate Filtrate Efficacy, Fluid Resistance, Delta P, Flammability

Results

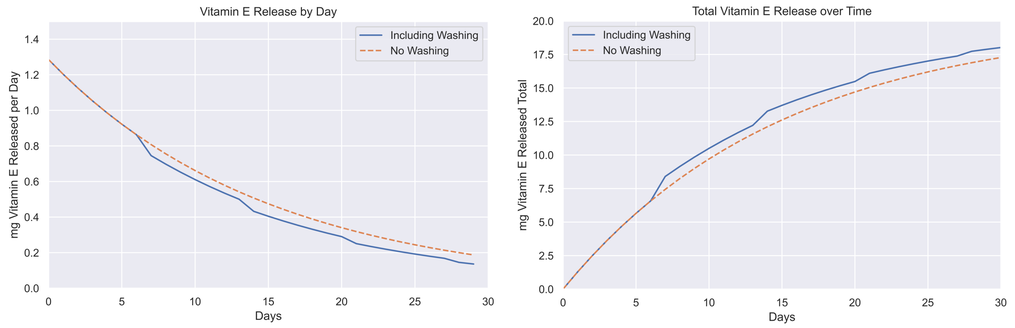
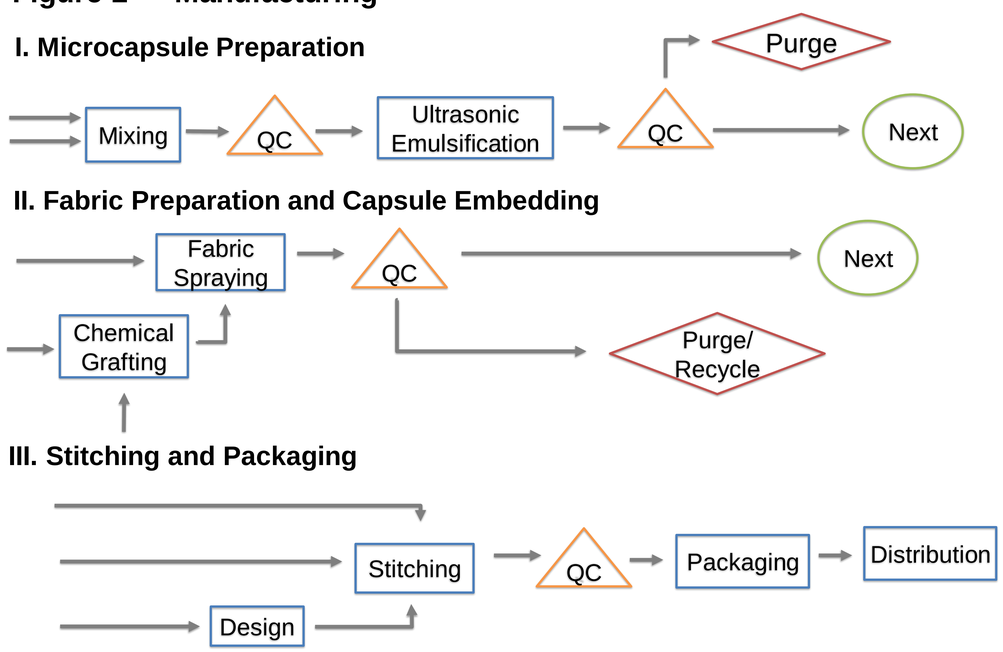


Figure 1—Release Kinetics of Vitamin E
The plots above show the total release of vitamin E and vitamin E over time over a one month time-span. The kinetics were modeled using the power-rule based Ritger Peppas model using parameters found in literature for a similar product. (insert reference here). Washing was assumed to happen weekly for 30 minutes, and was modeled using the same model, but a 10x larger rate parameter.

Manufacturing Process

Figure 2 — Manufacturing



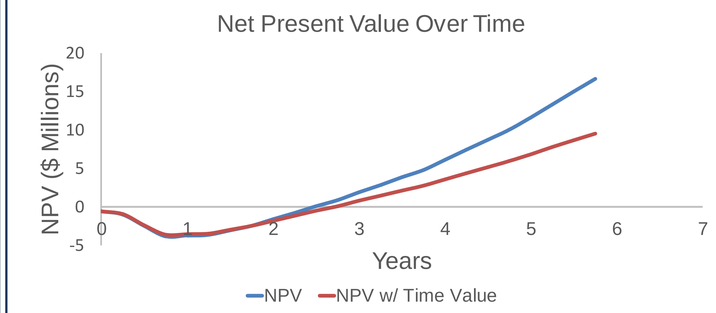


Figure 3 — Financial Analysis
Data shows that it will take 2.7 years to break even when considering the time value of money and 2.5 when not. There is about a 47% return after 6 years.

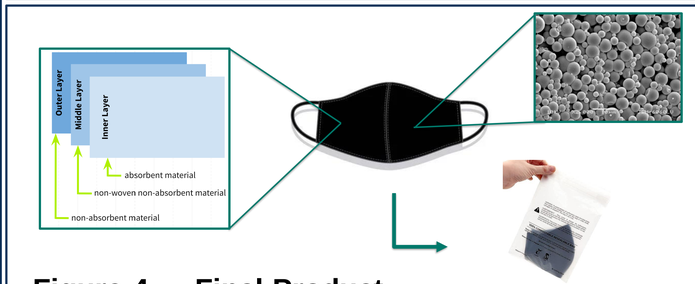


Figure 4 — Final Product
The final mask consists of three layers of absorbent, non-woven non-absorbent, and non-absorbent material with the innermost layer consisting of microcapsules.

References

Leaf Group. (n.d.). *The advantages of cotton clothing*. LIVESTRONG.COM. Retrieved February 28, 2022, from https://www.livestrong.com/article/59826-advantages-cotton-clothing/

Watson, K. (2019, March 7). *Vitamin E for face benefits, precautions, and most effective uses*. Healthline. Retrieved February 28, 2022, from https://www.healthline.com/health/vitamin-e-for-face#overnight-treatment

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Matthey, J. (2022, February 8). *Shea butter: Microcapsules sprayed to deliver active ingredients*. Johnson Matthey Technology Review. Retrieved February 28, 2022, from https://www.technology.matthey.com/article/66/1/90-102/

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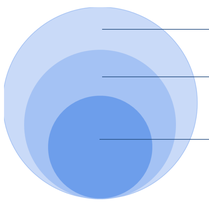
RECYCLE IT

All parts are biodegradable

Market & Challenges



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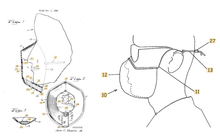
Primary and Secondary *(Cosmetic Masks And Other Facial Cosmetic Products)*

Tertiary *(Typical Face Masks)*

IP Challenges



- No currently active patents
- Many patents in development

Regulatory Challenges

FDA Mask Standards:

1. Bacterial/Particulate
2. Filtrate Efficacy
3. Fluid Resistance
4. Delta P
5. Flammability

Results

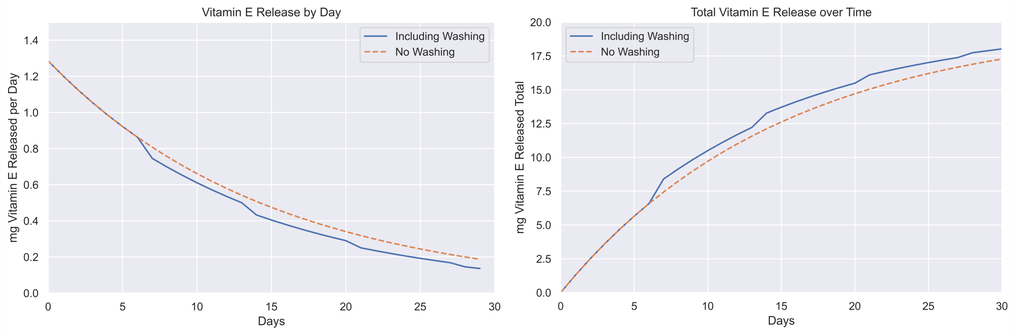


Figure 1—Release Kinetics of Vitamin E

The plots above show the total release of vitamin E and the vitamin E release by day over a one-month time-span given an 8-hour wear-period per day. The kinetics were modeled with the power-rule based Ritger Peppas model using parameters found in literature for a similar product[1]. Furthermore, boundary conditions of the model were reset at the end of the day, and no vitamin E was assumed when the mask was not worn. Washing was assumed to happen weekly for 30 minutes, and was modeled using the same model, but with a 10x larger rate parameter.

Manufacturing Process

Click to add text

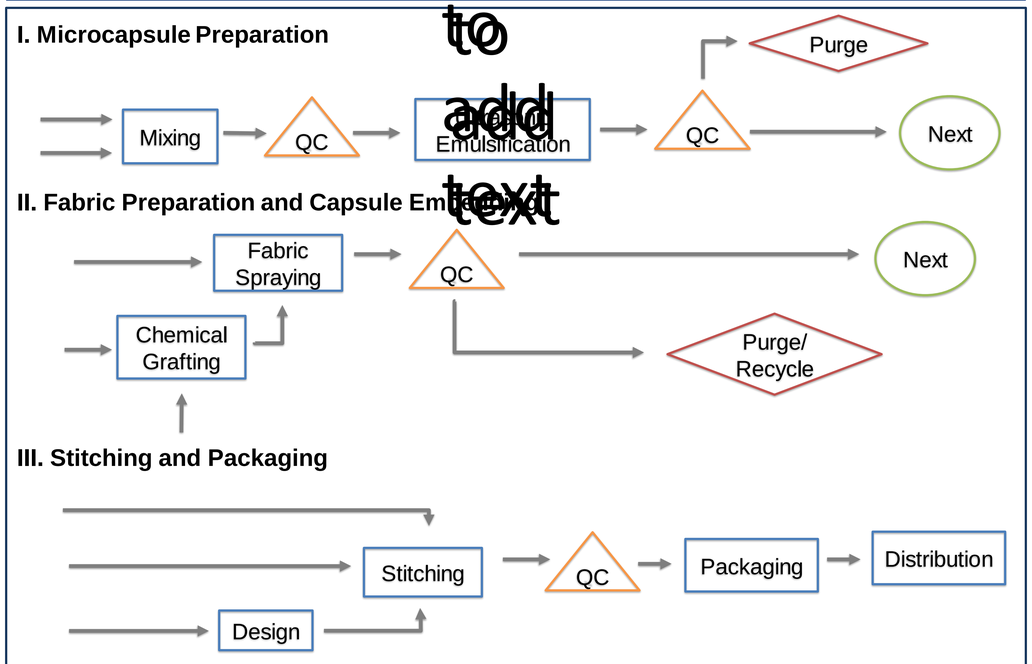
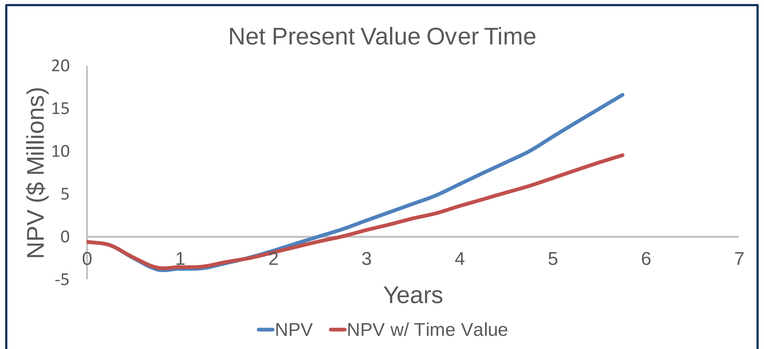
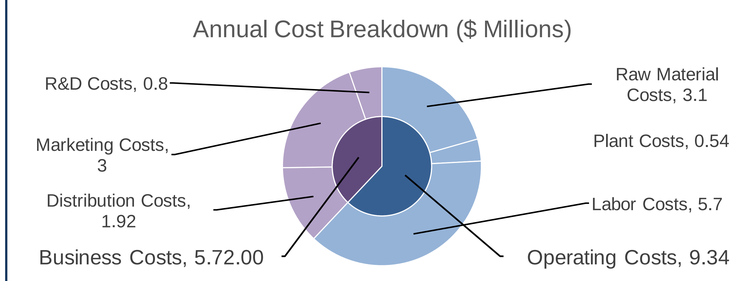


Figure 2 — Process Flow Overview

The diagrams above summarize the manufacturing process for our BreatheBeauty face masks. Microcapsules are first manufactured, then embedded into the mask fabric. The final mask is stitched together for packaging and distribution.





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Data shows that it will take 2.7 years to break even when considering the time value of money. After 6 years, the expected average annual rate of return is around 47%.

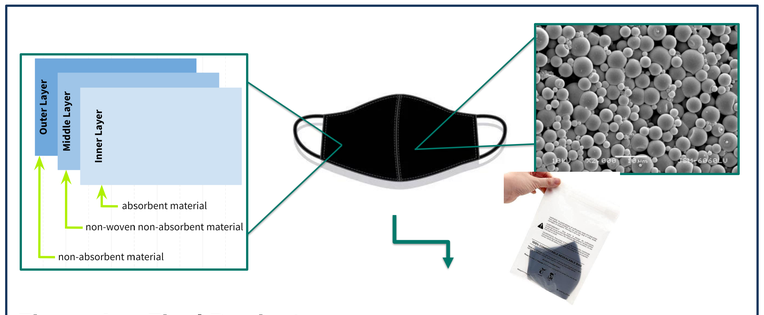

Figure 4 — Final Product

The final mask consists of three layers of absorbent, non-woven non-absorbent, and non-absorbent material with the innermost layer consisting of microcapsules.

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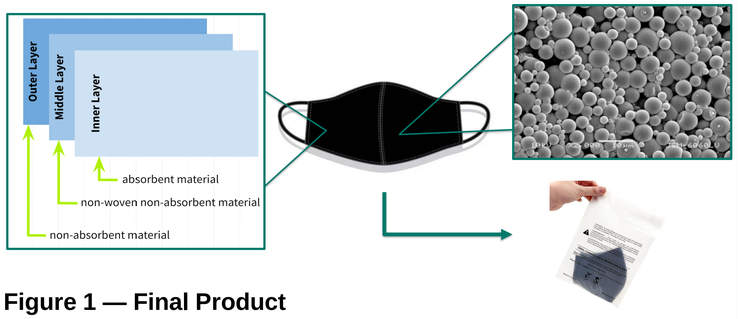
Product Design



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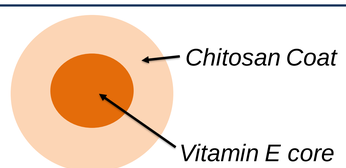
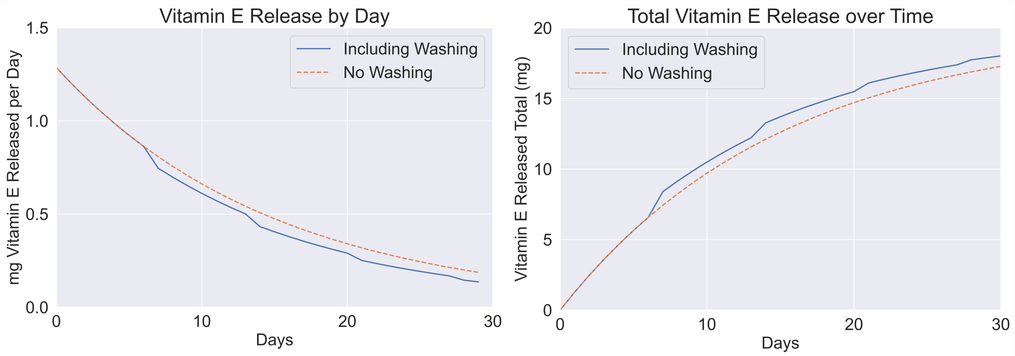


- Monodispersed populations with size 0.1 um resulting
- Highly negatively charged
- Entrapment efficacies of 99%
- Encapsulated α-tocopherol (TOC) → coated with chitosan

Figure 2 — Microcapsule
The final mask contains 0.1 g of microcapsules with 0.02 g of Vitamin E.

Kinetic Modeling



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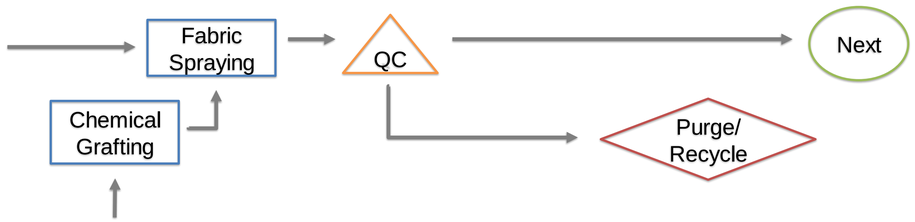
$$\frac{M_t}{M_0} = kt^n$$

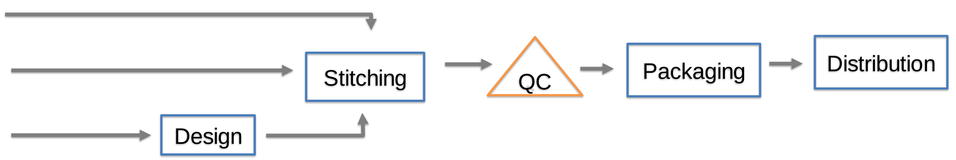
Manufacturing Process

I. Microcapsule Preparation

II. Fabric Preparation and Capsule Embedding



III. Stitching and Packaging



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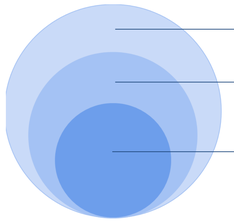
The diagrams above summarize the manufacturing process for our BreatheBeauty face masks. The process is a three-step process in series and can be scaled to produce approximately 10 million masks per year

Market & Challenges



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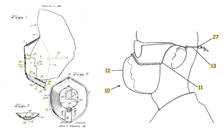

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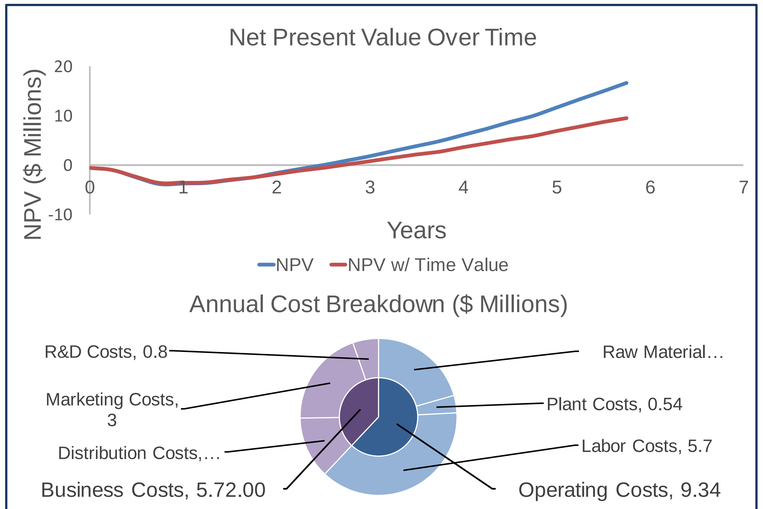
Financial Projections



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