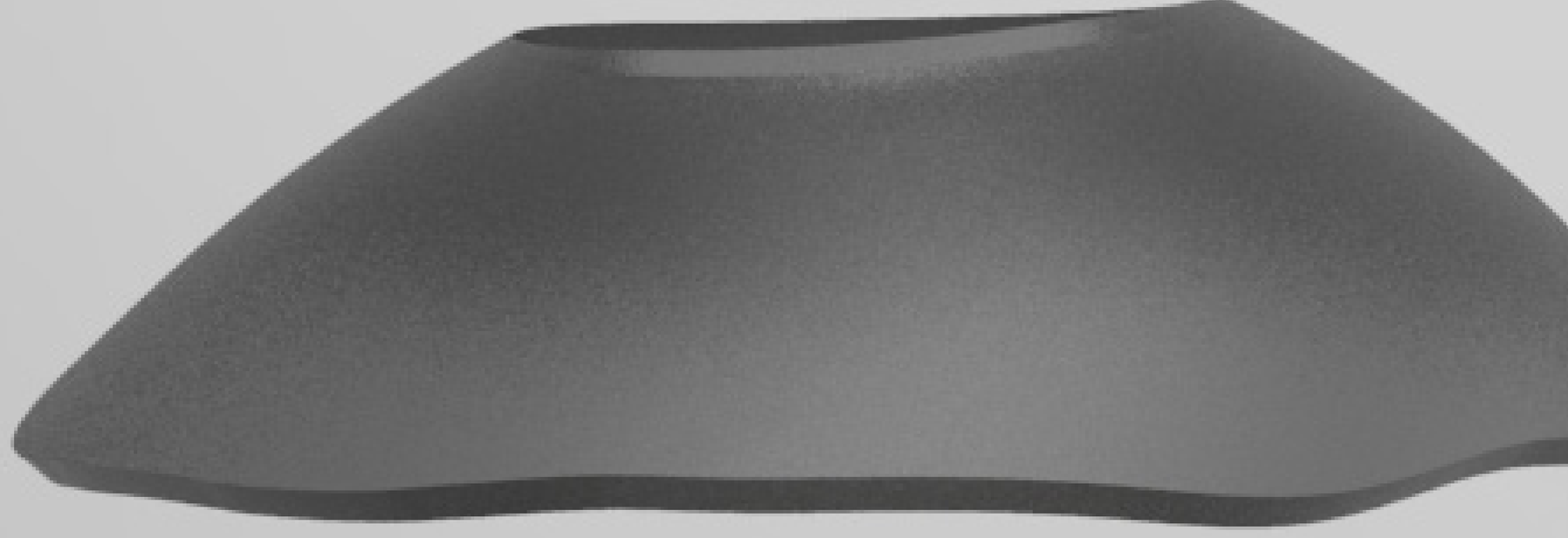
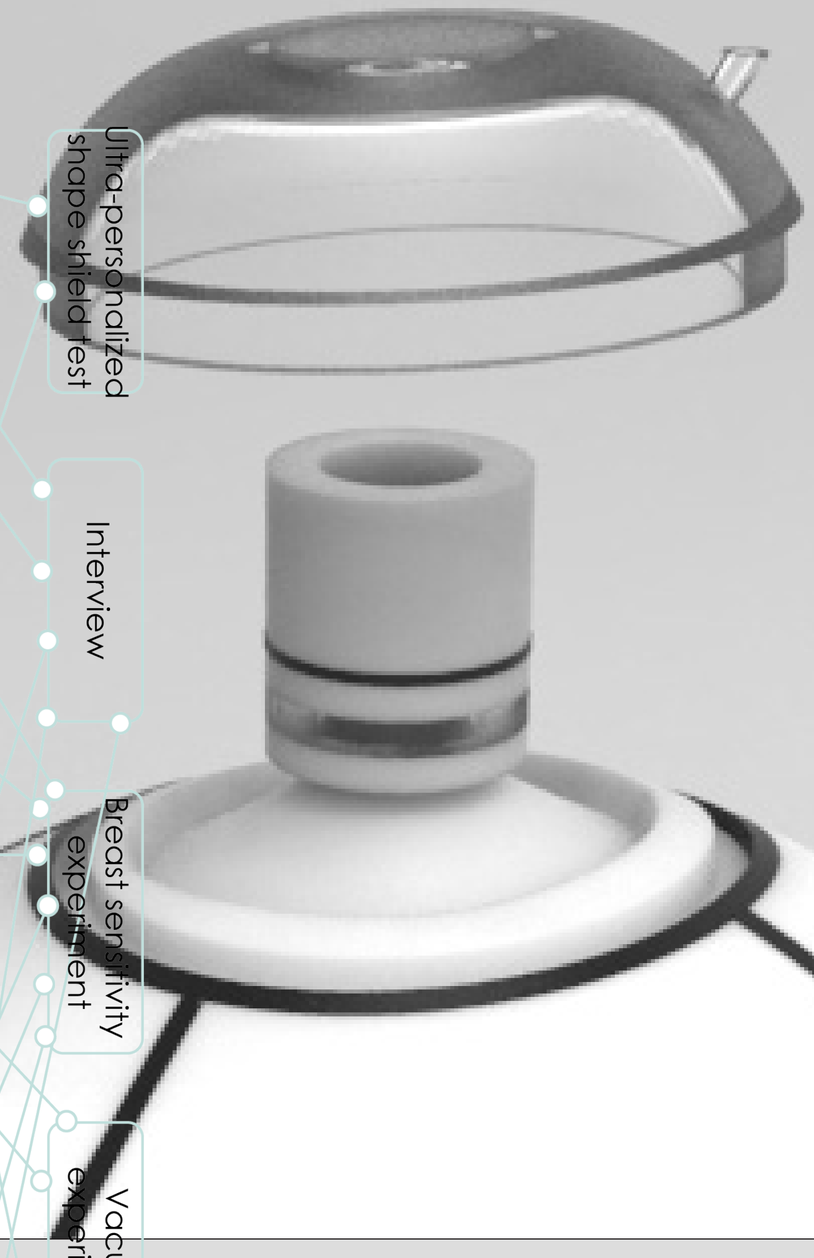
Breast pumps are often used by nursing mothers as breastfeeding support in lactation. However, breast pumping is sometimes not a pleasant journey for mothers. Pump-related discomfort and pain were reported by many women. The goal of this project is to optimise breast pumping ergonomic comfort by reducing discomfort and ultra-personalizing.





Ideal Breast Contour

- The breast pump shield design should perfectly fit the women's breast contour by 3D scanning; the right breast is different from the left one.
- The shield shape should be adjustable on nipple length, nipple diameter and breast angles. The adjustable parts should be easy to operate.
- The pressure and shield shape need to be modified during breast pumping as both breast shape (softness) and sensitivity reduces after milk comes out.

Ideal Pressure Distribution

- Pressure distribution for breast pump shield design could consider the breast sensitivity map as a reference.
- Compressive pressure on the nipple-areola complex should be lower while applying the vacuum, or the two pressure can be applied separately.
- The shield should protect the nipple and areola, especially the nipple top, under vacuum.
- The breast pump shield should cover as larger breast areas as possible to lower the pressure.
- Pressure should be applied on four breast quadrants evenly.
- The vacuum intensity should be adjustable and may be at most 0.67N.
- The vacuum should not make the nipple and areola deform more than 1.86 m^3.

Effective Stimuli

- The duration of compression and vacuum on the nipple-areola complex should be reduced to less than 20 minutes to avoid tissue damage.
- The design should decrease friction on the nipple-areola complex.
- The compression should be higher than the tactile thresholds and not exceed the users' discomfort thresholds.
- The design should stimulate more nipple base and areola areas; stimulate fewer or avoid nipple side and nipple top areas.

Other Personalization

- Women with smaller breasts, shorter nipples, and lower weight/BMI should apply less pressure to the breast.
- Design concepts that benefit hormone release should be considered.

Side Issues

- The breast pump should be easy-to-use, efficient and could fit various contexts.
- The breast pumps should be innovative and competitive in the large market.
- Massage is helpful, but the mechanisms should be well considered.
- The breast pumps could design with a temperature of 35.5°C to 37.5°C to improve comfort.
- Pumping privacy is essential; the breast pump could be "invisible" in daily use.

Ultra-personalized shape shield test

Interview

Breast sensitivity experiment

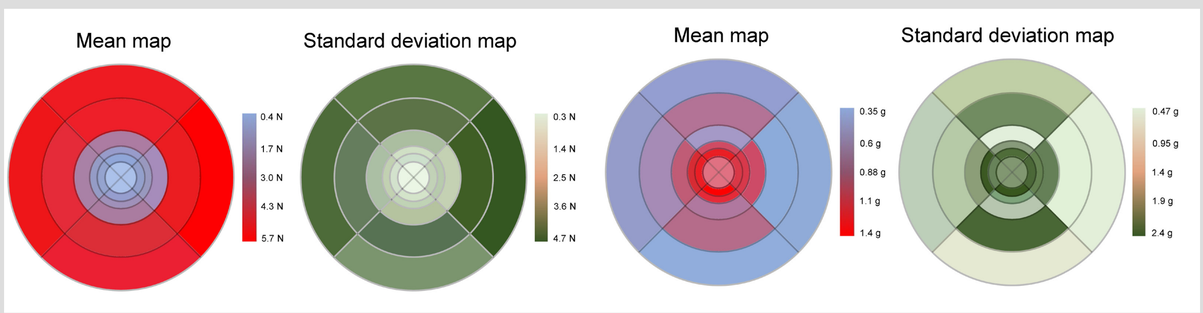
Vacuum experiment

Literature

Vitual exploration

Experiments regarding breast sensitivity were implemented on 20 women to explore the discomfort thresholds and lower sensory thresholds of women's breasts. Two breast sensitivity map towards positive pressure was made to present the difference: the breast discomfort thresholds increase from the nipple top to the outer breast. The breast tactile thresholds decrease from the nipple side to the outer breast, and the sensitivity of nipple top is between the nipple base and the areola.

The consolidated LoR was created, and it was applied for a design proposal, which has an ultra-personalized adjustable shield shape with better pressure distribution and bigger contact areas.



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