

APPENDIX

DESIGNING A SHAPE MORPHING, REUSABLE, BLOOD-COLLECTING HOLLOW TAMPON WITH SHAPE MEMORY WIRE



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Appendix A – Project brief

Personal Project Brief - IDE Master Graduation



Designing a deployable and reusable 'hollow tampon'

project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 11 - 05 - 2021

21 - 01 - 2022

end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Currently there is a limited choice in menstruating products with the goal of collecting the blood and preventing leakage. The main period products that are used outside the vagina are: sanitary pads, reusable period pads, period underwear, and panty liners (see figure 1 for an overview of all period products). Period products that need to be inserted mainly consist of tampons, menstrual cups and menstrual discs. Out of these options the reusable period pads, period underwear and the menstrual cups (and a couple of menstrual discs) are the only reusable products. It is estimated that an individual uses an average of 11.000 tampons in a lifetime (Safe Cosmetics, 2016), which generates a significant source of waste. Period poverty is also a problem, 9% of women in the Netherlands, between 12 and 25 years old, sometimes do not have enough money to buy necessary period products (Plan International, 2019). In Flanders this number is even higher: 12% (Caritas Vlaanderen, 2020). Reusability is important because it generates a smaller environmental impact and it has a financial advantage (see figure 2).

The brand Beppy is part of Asha International, a Dutch manufacturer and wholesaler of pharmaceuticals and personal care products such as tampons, condoms, lubricants and massage oils. Beppy recently developed a redesign of the menstrual cup. The Beppy cup differentiates itself from others by its new innovative design consisting of an anti-leakage edge, extra soft material to better fit to the shape of the body, and a loop to make it easier to take out the cup. Their focus is on freedom, 'allowing women not to be inhibited by their period', making it possible to sport, swim, go to the sauna, and having sex. Furthermore, they are open and honest about risks like Toxic Shock Syndrome by communicating in a positive manner and with humor on their social media platforms.

Beppy received feedback from 4 users that the cup was too big. This led to me performing my own preliminary research done with 46 women. Almost 1 out of 5 said the reason why they did not try/were hesitant about the menstrual cup, was them feeling intimidated by its size. Beppy wants to be inclusive for as many vaginas possible, so designing a product that appeals to more menstruating people, would be a great addition to their product line. Because the product is inserted into the body, it is limited by the materials that can be used. Furthermore, the impact it has on the vagina needs to be taken into account, medical considerations and norms are important to include. In the EU, period products are not medical devices. However, Beppy keeps the guidelines of medical devices in mind and does perceive its products as medical devices. Gynaecologists are therefore an important stakeholder, their knowledge is valuable and they could eventually recommend the product to patients.

The main customers of Beppy are menstruating people in their mid twenties to their mid thirties, according to the selling statistics from their website. For this project I will focus on the target group of menstruating people going from 18 years old to 35 year old. They are usually already more comfortable with their body, are still open to try new products and are not yet around the age of menopause (which on average occurs in their 40s to 50s). Furthermore, the product will be targeted towards people living in Europe with access to clean water and toilets. People with vaginismus and endometriosis (and other vaginal conditions that influence inserting products) will not be a main focus, it would only be an added advantage if they are also able to use the product. At last, it is targeted towards people who are not restricted by their culture and/or environment to use insertable period products.

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Personal Project Brief - IDE Master Graduation



introduction (continued): space for images



image / figure 1: Overview of period products (photos from Pexels) & Beppy products



image / figure 2: Infographic about reusable period product alternatives vs disposables (source: Zero Waste Europe)

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Below the problem definition can be found with the three focus points arranged according to priority for this project.

Menstruating people, with a tampon as preferred use of period product, do not yet have an alternative that is more sustainable, like period pants are for pads (1. Reusability). The only reusable, insertable alternative that is widely known and available is the menstrual cup. Still, its functions are widely different from a tampon as it sits high into the vagina close to the cervix and has no part sticking out of the vagina for easy access to take it out (2. Insertability). Preliminary findings indicated that a significant part of menstruating people, do not feel comfortable inserting a cup and may feel intimidated by its perceived size (3. User experience).

In conclusion, there is a need for a new reusable period product that has a similar size and function as a tampon and which is perceived as less intimidating to insert than a menstrual cup. This concerns menstruating people from 18 to 35 years old, living in Europe with access to clean water and toilets, and who are not limited by their culture/environment/own body to use insertable period products.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

Designing a new suitable menstruation product for Beppy that is reusable, has a similar (deployable) size and function as a tampon, and which is perceived as less intimidating to insert than a menstrual cup. In addition, applying appropriate researched manufacturing techniques during the process.

This can be achieved by: Identifying appropriate (smart) materials which can be reused and inserted into the vagina, and collecting corresponding manufacturing techniques. Eventually using this knowledge to apply the materials and manufacturing techniques to the new design. Creating a form that takes into account the ergonomics of inserting, wearing, and taking out (also keeping in mind cleaning and storing). Performing user tests with the target group to evaluate if the new product is perceived as less intimidating than the cup and if the form is ergonomic.

Deliverables:

- Analysts: list of requirements & wishes, report of appropriate (smart) materials and manufacturing techniques with pros and cons for applying them to product.
 - Idea generation & conceptualisation: at the mid-term, an overview of ideas to conceptualise, afterwards creating some first prototypes and performing user tests (formative). At the end, choosing a concept with gained knowledge.
 - Embodiment: executing two iterations by testing (formative) with appearance models for user experience of perceived size and functional prototypes with proposed material to test functions of design.
 - Finalisation: digital visualisation, appearance model and functional prototype of final design with overview of conclusions of final opinions and experiences of people involved (summative), written report including recommendations for Beppy for further development and optimisation. Final presentation to showcase design.
- If it is not possible for the model to be inserted into the vagina because of medical or ethical reasons, the assessment criteria will be adjusted in a way that the target group can still give their opinions and where conclusions can be made.

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 11 - 5 - 2021

21 - 1 - 2022

end date



This project is divided into four phases. The first one is the analysis, here research is done to gain knowledge on materials, manufacturing techniques, the user, experts, state of the art technology, .. Some first ideas that come to mind can be explored. With this knowledge, the programme of requirements and wishes can be adjusted and idea generation can begin. According to the available materials and designs, concepts are chosen and prototyped. The experience of the user is priority, which is why I hope to do at least two iterations in the embodiment phase with the chosen concept to really find a suitable final design. The final design will be evaluated by the user, stakeholders and experts one last time to gather final information about the product and for recommendations of further development. During the whole process I plan to keep in touch with the user and experts, like gynaecologists, to apply their knowledge and feedback to the project.

I am planning to work 4 out of 5 days a week. Because of Pre-Menstrual Dysphoric Disorder (PMDD) I need a lot more rest the two weeks before my menstruation, symptoms like fatigue, low energy, low motivation, anxiety, depressed mood.. arise which makes working full-time impossible if I also want to take my mental health into account.

Due to family circumstances I was not able to work more than 1 or 2 days in the first 9 weeks. This is also the reason why I scheduled a 3 week vacation, to take some rest and have a fresh start afterwards.

After finalizing the conceptualisation phase I have a week vacation planned and then in December there is the Christmas holidays.

During this project my mental health is my first priority.

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, Stick to no more than five ambitions.

I set up this project because I am interested in femtech, technology focused on women's health. After reading the book Invisible Women by Caroline Criado-Perez, I was sure I wanted to do something that has a positive impact for women. I was surprised how big the gap was between men and women on many levels. Definitely a lot can be improved with research and designing products taking into account the sex and gender of people. My internship focused on sustainability, one of my main interests, which is why I was also appealed by reusable menstrual products.

Helping to solve societal issues is something I want to explore more. With this project the experience of the user is the main focus. Furthermore, this is a rather sensible/taboo topic which makes it interesting to learn how to address it. I hope to prove that I am capable of listening to the user in combination with performing research and applying and transforming this into a product.

Personal ambitions:

- Finding a working style that fits me and has a better balance between work and mental health, minimizing stress and setting clear boundaries that I will not cross.
- Using at least two new design methods/tools/way of prototyping
- Learning how to talk about and address a taboo subject
- Being more proactive about reaching out to and using more resources.
- Improving my skills with Illustrator by making my own illustrations for the report

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

During my project I will refer to 'menstruating people' or 'menstruators' which includes all those who have a menstrual cycle: not only women but also AFAB (Assigned Female At Birth) individuals. This is to be inclusive for those who do not identify themselves as woman and are for example transgender men or non-binary people. When I talk about the vagina, I am referring to the muscular canal that connects the uterus and cervix to the outside of the body. The vulva is the outer part of the female genitalia.

Appendix B – List of vaginal conditions

- Menopause (genitourinary syndrome of menopause, or GSM)
- Vaginismus (Levator myalgia)
- Dyspareunia (Painful sex)
 - Vaginitis
 - Uterine fibroids
 - Irritable bowel syndrome
 - Endometriosis
 - Injury from childbirth
- Vaginal septum
- Imperforate hymen
- Vaginal issues related to cancer therapy
- Mayer-Rokitansky-Küster-Hauser (MRKH) Syndrome
- Post-surgical vaginal swelling
- Chronic pelvic pain
- Vulvodynia
- Vaginal stenosis

Appendix C – The female reproductive cycle

This project is about a new menstrual product, which means taking a look at the menstrual cycle is a necessity. How does it happen, how much blood is lost, ...?

1.1.1 TWO CYCLES

The female reproductive cycle can be split into two cycles:

1. **The ovarian cycle** where a follicle is developed every cycle
2. **The uterine or menstrual cycle** where the endometrium is prepared to receive an egg every month

The length of the menstrual cycle is the number of days between the first day of menstrual bleeding of one cycle to the beginning of the next bleeding. On average a menstrual cycle has a duration of 28 days with most cycle lengths between 25 to 30 days (Mihm et al., 2011). Furthermore the duration of the bleeding itself varies from person to person, ranging from two to eight days with an average duration between four to six days.

1.1.2 FOLLICULAR OR PROLIFERATIVE PHASE

WHAT HAPPENS IN THE OVARIES

Several follicles develop in the ovaries and at about day 6, one of the follicles has outgrown the others and becomes the dominant one. During the final maturing process, the mature follicle continues to increase its production of **estrogens** which can be seen in the graph of the ovarian hormone levels (Figure 4.10). This time frame is termed the **follicular phase** because ovarian follicles are growing and developing.

WHAT HAPPENS IN THE UTERUS

Due to the rise of **estrogens**, the repair of the **endometrium** is stimulated and its thickness approximately doubles, to about 4-10mm (Tortora & Derrickson, 2017). This is called the **proliferative phase** because the endometrium is proliferating, which means to reproduce rapidly.

1.1.3 OVULATION

In the brain the **hypothalamus** secretes the **gonadotropin-releasing hormone (GnRH)** which stimulates the **pituitary gland** to produce **follicle stimulating hormone (FSH)** and **LH** (the pituitary hormones). This creates an even higher level of **estrogen** in the follicle, which on its turn stimulates the gland to produce a higher level of **LH**, which eventually causes **ovulation**. This means the mature follicle ruptures and releases the secondary oocyte into the pelvic cavity, this usually occurs on day 14 in a 28-day cycle (Mihm et al., 2011). A rising level of LH can be used to predict the ovulation a day in advance (Tortora & Derrickson, 2017).

1.1.4 LUTEAL OR SECRETORY PHASE

This phase is the time between ovulation and the beginning of the next menstrual bleeding. It lasts for 14 days in a 28-day cycle, from day 15 onwards. In Mihm's paper (2011) it is mentioned that the **luteal phase** of the cycle is relatively constant in all people, with a duration of 14 days. The variability of cycle length can be found in the varying lengths of the **follicular phase** of the cycle, which can range from 10 to 16 days.

WHAT HAPPENS IN THE OVARIES

After ovulation the ruptured mature follicle collapses, under the influence of LH the cells mix and transform into the **corpus luteum**. The corpus luteum produces hormones and therefore creates a new rise in estrogens and progesterone which stop the release of FSH and LH. This phase is called the **luteal phase**.

If the oocyte is not fertilized, the corpus luteum has a life span of only 2 weeks. Afterwards the levels of estrogens and progesterone decline whereas the **FSH** and **LH** can rise again. This means follicular growth resumes and a new ovarian cycle begins.

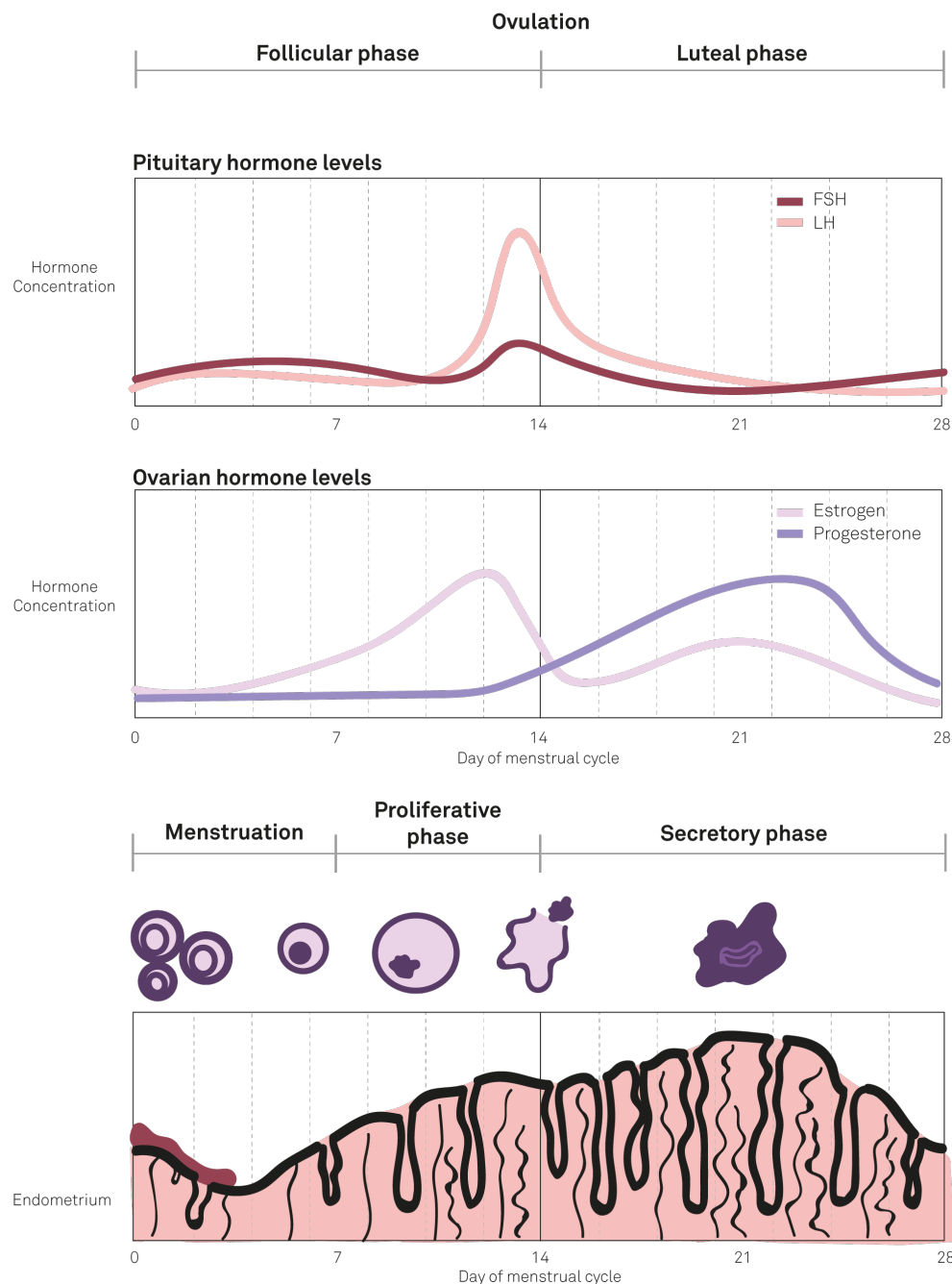


Figure 1.1 Overview of the menstrual cycle, different phases of hormone levels and endometrium

WHAT HAPPENS IN THE UTERUS

Progesterone and estrogens produced by the corpus luteum promotes the thickening of the endometrium to about 12-18mm (Tortora & Derrickson, 2017). Because of the secretory activity of the endometrial glands, which begin to secrete glycogen, this period is called the **secretory phase** of the uterine cycle. If fertilization does not occur, the levels of progesterone, estrogens and estradiol decline due to degeneration of the corpus luteum. This withdrawal of progesterone and estrogens causes the functional layer of the endometrium to shed and so menstruation begins and a new menstrual cycle starts.

- Endometrium: the inner mucosal lining of the uterus
- Atresia: programmed self-destruction
- Gland: any structure that makes and secretes a hormone

1.1.5 QUANTITY OF BLOOD LOSS

The mean value of the menstrual blood loss was 43.4+ 2.3 ml in the entire series. There were no great differences in amount of blood lost between different ages except in the 15-year-group which had the smallest and in the 50-year-group which had the highest mean value of menstrual blood loss (Hallberg et al., 1966).

it was concluded that the upper normal limit of the menstrual blood loss is situated between 60-80 ml and that a blood loss above 80 ml should be regarded as pathological (Hallberg et al., 1966).

Appendix D – History of the tampon

Tampons have been around for thousands of years, only in different forms. Materials used were papyrus, wool, paper, grasses, mosses, and other plants. The tampons as we know them today were invented by Earle Haas and patented in 1933. His design was made of compressed cotton with a string in the centre and housed in a paper tube (an applicator). Not much later, in 1934 Gertrude Schulte Tenderich bought the patent and started the company Tampax. Tampax is US based, so it was only around 1945, with the introduction of the o.b. tampon (without applicator), that the tampon reached the market in Europe.

Since then, more research has been done, leading to improvements in materials and absorbance and minimizing the chances of Toxic Shock Syndrome. Though, the overall shape stayed the same. This section discusses three innovative tampon products, each tackling a different problem.

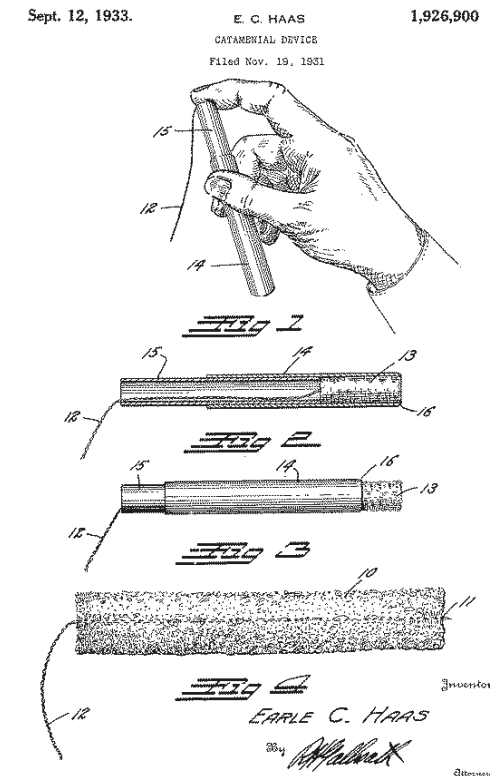


Figure 1.2 Patent of the tampon by Earle Haas 1933.

Appendix E – History of the cup

Cups have become more prevalent in the last few years, though they have been around since the 1930's, just like tampons. It is said that the Daintette made by the Dainty Maid, Inc. in the US is the first menstrual cup (). It got patented in 1935.

The first commercially sold modern menstrual cup was by Leona Chalmers in the late 1930's, named Tassette (). Still, a lot of taboo was surrounded by insertable products so the market remained limited.

In the early 2000's the bell shaped cups as we know them today were developed (Figure 4.17). Furthermore, instead of using rubber, MoonCup opted for medical-grade silicone. From the 2010's on, the menstrual cup industry expanded exponentially. There are over 50 menstrual cup brands with differences in sizes, shapes, materials, ... In Appendix FIXME, an overview can be found of a part of these brands. In the following section, more about the shapes and dimensions will be discussed.

First, the Beppy cup and then two other kinds of cups are analysed to see which makes them innovative and what characteristics are great possibilities to implement.



Figure 1.3 Daintette cup, patented 1935

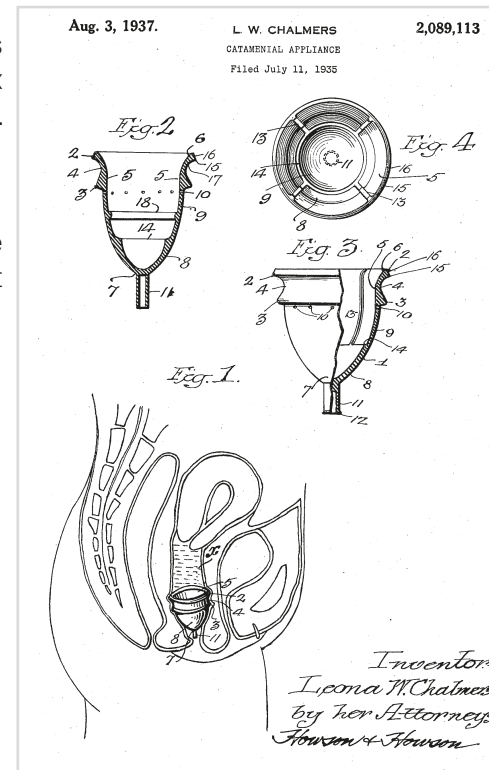
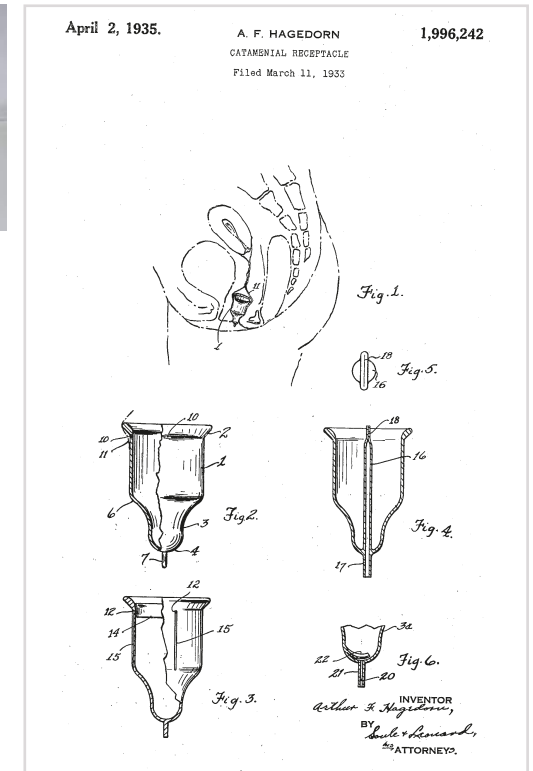


























































Figure 1.4 Tassette cup, patented 1937

































Appendix E – List of menstrual cups retrieved from theecofriendlyfamily.com

	Brand	Image	Size	Length (mm)	Diameter (mm)	Capacity (To Holes) (ml)	Capacity (Listed) (ml)	Stem	Firmness
Aisle	Aisle		S	53,00	42,00		30	13 mm Round Hollow	N/A
	Aisle		L	53	45		30	13 mm Round Hollow	N/A
Best Periodt	Best Periodt		S	55	43		29	12 mm Solid	3
	Best Periodt		L	57	46		40	12 mm Solid	3
Bloody Buddy	Bloody Buddy		T	53	38	18	18	12 mm Solid	N/A
	Bloody Buddy		S	54	41	23	23	16 mm Solid	N/A
	Bloody Buddy		L	58	44	25	25	22 mm Solid	N/A
Blossom	Blossom		S	52	42	22	20	10 mm Solid Round	3
	Blossom		L	55	45	27	25	10 mm Solid Round	3
bfree	bfree		S	44	38	13	10	7 mm Nub	3
	bfree		M	48	42	18	15	9 mm Nub	3
	bfree		L	53	48	30	25	11 mm Nub	5
Cora	Cora		S	46	42	17	21	19 mm Solid Round	3
	Cora		L	51	46	22	28	15 mm Solid Round	3
Diva Cup	Diva Cup		XS (o)	57	40		17	10 mm Hollow Round	3
	Diva Cup		S (1)	57	43	24	30	10 mm Hollow Round	3
	Diva Cup		L (2)	57	46	28	30	10 mm Hollow Round	3
Dot	Dot		OS	50	45	28	28	17 mm Solid Notched Tab	2
EvaCup	EvaCup		S	48	43	25	25	14 mm Solid Round	3
	EvaCup		L	51	46	30	30	16 mm Solid Round	3
Femmecup	Femmecup		OS	50	45		30	15 mm Solid Round	N/A
	FemmyCycle		S	38	31	20	17	19 mm Ring	2
FemmeCycle	FemmyCycle		L	43	36	25	30	20 mm Ring	2
	FemmyCycle		Low	43	36	25	30	6 mm Ring	2
Flex	Flex		S	46	43		22	28 mm Pull Ring	N/A
	Flex		L	53	46	30	30	28 mm Pull Ring	N/A
Formoonsa	Formoonsa		T	31	36	10	10	24 mm Loop	4
	Formoonsa		S	37	44	20	20	15 mm Loop	3
	Formoonsa		L	44	48	30	30	10 mm Loop	4
	Formoonsa		XL	52	46	30	30	18 mm Solid Flat	Soft 3/Classic 4

	Brand	Image	Size	Length (mm)	Diameter (mm)	Capacity (To Holes) (ml)	Capacity (Listed) (ml)	Stem	Firmness
Fun Cup	Fun Cup		S (A)	53	40	20	20	None	1
	Fun Cup		L (B)	58	43	30	30	None	1
Fleurcup	Fleurcup		S	47	41		20	23 mm Solid Flat	3
	Fleurcup		L	52	46		28	18 mm Solid Flat	3
Flove	Flove		S	47	41		20	19 mm Solid	N/A
	Flove		L	54	45		30	16 mm Solid	N/A
Genial Day	Genial Day		M	59	40	25	30	11 mm Hollow Round	2
	Genial Day		L	59	45	29	30	11 mm Hollow Round	2
Hello (TPE)	Hello (TPE)		XS	47	38	17	17	10 mm Solid Round Nub	5
	Hello (TPE)		S/M	49	41	21	21	10 mm Solid Round Nub	5
	Hello (TPE)		L	54	45	28	28	10 mm Solid Round Nub	5
Hello Low Cervix (TPE)	Hello Low Cervix (TPE)		S/M	43	41	21	21	None	5
	Hello Low Cervix (TPE)		L	49	45	28	28	None	5
	Hello Low Cervix (TPE)		L	49	45	28	28	None	5
Honey Pot	Honey Pot		S	54	42		25	18 mm Round Hollow	N/A
	Honey Pot		L	57	45		30	20 mm Round Hollow	N/A
JuJu Cup	JuJu Cup		S	46	40	18	20	19 mm Solid Thin	4
	JuJu Cup		L	50	46	27	30	19 mm Solid Thin	4
	JuJu Cup		4 Low	40	48	23	23	10 mm Solid Thin	4
	JuJu Cup		3 High	58	40	22	22	20 mm Solid Thin	4
Keeper	Keeper (Rubber)		L (A)	54	45	15	25	25 mm	5
	Keeper (Rubber)		S (B)	54	46		21	25 mm	5
	Keeper Moon Cup		L (A)	54	45	15	25	25 mm	N/A
Kind	Keeper Moon Cup		S (B)	54	46		21	25 mm	N/A
	Kind Cup		S	46	38	19	23	33 mm Solid	2
LadyCup	Kind Cup		L	44	38	25	35	43 mm Solid	2
	LadyCup		S	46	40	15	21	19 mm Hollow Round	5
LaliCup	LadyCup		L	53	46	21	34	13 mm Hollow Round	5
	LaliCup		S	46	40	22	27	25 mm	3
	LaliCup		M	51	44	30	36	22 mm	3
	LaliCup		L	54	47	35	41	19 mm	3

	Brand	Image	Size	Length (mm)	Diameter (mm)	Capacity (To Holes) (ml)	Capacity (Listed) (ml)	Stem	Firmness
LENA	LENA		S	46	41	21	25	25 mm Solid Flat	4
	LENA		L	51	45	30	30	19.7 mm Solid Flat	4
	LENA Sensitive		S	46	41	21	25	25 mm Solid Flat	2
	LENA Sensitive		L	51	45	30	30	19.7 mm Solid Flat	2
Leona Air Flow	Leona Air Flow		S	54	41	22		13 mm Round Hollow	4
	Leona Air Flow		L	58	45	30		13 mm Round Hollow	4
Lily Cup	Lily Cup		S	78	40	25	25	Length incl stem	2
	Lily Cup		L	78	44	28	28	Length incl stem	2
	Lily Cup Compact		S	58	42	15	20	Length incl stem	1
	Lily Cup Compact		L	58	45	20	25	Length incl stem	1
LoutLou	Lily Cup One		OS	47	39	20	20	Length incl stem	1
	LouLou		S	45	42	20	25	25 mm Solid Round	Blue 3/Pink 4
	LouLou		L	50	46	30	30	20 mm Solid Round	Blue 3/Pink 4
Lumma	Lumma		S	38	41		13	14 mm Round Hollow	3
	Lumma		SB	35	38		10	16 mm Round Hollow	3
	Lumma		MB+	46	39		23	16 mm Round Hollow	3
	Lumma		M+	42	37		17	18 mm Round Hollow	3
	Lumma		MB	48	41		17	14 mm Round Hollow	3
	Lumma		M	45	38		12	16 mm Round Hollow	3
	Lumma		HB+	55	54		36	13 mm Round Hollow	3
	Lumma		H+	54	41		29	13 mm Round Hollow	3
Lunette	Lumma		HB	57	44		22	15 mm Round Hollow	3
	Lumma		H	57	38		20	15 mm Round Hollow	3
	Lunette		S (1)	47	41	21	25	25 mm Solid Flat	3
Luv Ur Body	Lunette		L (2)	52	46	27	30	20 mm Solid Flat	4
	Luv Ur Body		S	47	42	25	25	18 mm Leaf	4
	Luv Ur Body		M	62	45	38	45	20 mm Leaf	4
Mermaid Cup	Luv Ur Body		L	57	48	36	46	20 mm Leaf	4
	Mermaid Cup		S	52	42	16	28	24 mm Solid	2
	Mermaid Cup		L	56	46	20	34	24 mm Solid	2

	Brand	Image	Size	Length (mm)	Diameter (mm)	Capacity (To Holes) (ml)	Capacity (Listed) (ml)	Stem	Firmness
Mermaid Guppy	Mermaid Guppy		S	40	45		24	24 mm Solid	TBD
	Mermaid Guppy		L	40	48		28	24 mm Solid	TBD
MCUK	MCUK (Mooncup UK)		L (A)	50	46	20	30	21 mm Hollow Round	N/A
	MCUK (Mooncup UK)		S (B)	50	43	15	29	21 mm Hollow Round	N/A
MeLuna	MeLuna (TPE)		S	45	38	15	15	12 mm Stem, 8 mm Ball, or 10 mm Ring	Classic 4 / Soft 2 / Sport 5
	MeLuna (TPE)		M	48	41	20	20	13 mm Stem, 9 mm Ball, or 12 mm Ring	Classic 4 / Soft 2 / Sport 5
	MeLuna (TPE)		L	51	44	24	24	15 mm Stem, 11 mm Ball, or 15 mm Ring	Classic 4 / Soft 2 / Sport 5
	MeLuna (TPE)		XL	56	47	28	30	15 mm Stem, 9 mm Ball, or 13 mm Ring	Classic 4 / Soft 2 / Sport 5
Merula	MeLuna (Shorty TPE)		S	35	38	8	8	12 mm Stem, 7 mm Ball, or .10 mm Ring	Classic 4 / Soft 2 / Sport 5
	MeLuna (Shorty TPE)		M	38	41	10	10	13 mm Stem, 7 mm Ball, or .10 mm Ring	Classic 4 / Soft 2 / Sport 5
	MeLuna (Shorty TPE)		L	41	44	14	14	14 mm Stem, 7 mm Ball, or 11 mm Ring	Classic 4 / Soft 2 / Sport 5
	MeLuna (Shorty TPE)		XL	44	47	16	16	15 mm Stem, 8 mm Ball, or 11 mm Ring	Classic 4 / Soft 2 / Sport 5
MonthlyCup	Merula		One Size	39	46	38	38	72 mm ladder (trimmed 61 mm or 50 mm)	5
	Merula XL		OS	50	46	50	50	26 mm Ladder	5
	MonthlyCup		S	45	37	15	15	10 mm Thin Solid	3
MyCup	MonthlyCup		M	55	43	22	22	10 mm Thin Solid	5
	MonthlyCup		L	55	47	30	34	10 mm Thin Solid	5
	MyCup		T	45	38	16	22	18 mm Solid	5
NÜDIE	MyCup		S	45	42	22	29	18 mm Solid	4
	MyCup		L	51	46	31	40	16 mm Solid	4
	NÜDIE		S	56	38	18	18	Pebble Inc. in Length	N/A
Oi	NÜDIE		M	61	42	25	24	Pebble Inc. in Length	N/A
	NÜDIE		L	66	46	34	32	Pebble Inc. in Length	N/A
	Oi (TPE)		S	49	35	17	30	11 mm Hollow Round	2
OrganiCup	Oi (TPE)		M	59	40	25	30	11 mm Hollow Round	2
	Oi (TPE)		L	59	45	29	30	11 mm Hollow Round	2
	OrganiCup		Mini	44	37	15	15	14 mm Stem	2
Ruby Cup	OrganiCup		A	50	40	21	25	15 mm Stem	2
	OrganiCup		B	55	45	27	30	15 mm Stem	2
	Ruby Cup		S	46	40	20	24	19 mm Stem	2
	Ruby Cup		M	51	45	24	34	17 mm Stem	2

	Brand	Image	Size	Length (mm)	Diameter (mm)	Capacity (To Holes) (ml)	Capacity (Listed) (ml)	Stem	Firmness
Saalt	Saalt		T	45	38		15	20 mm Solid Flat	3
	Saalt		S	47	41	20	25	23 mm Solid Flat	4
	Saalt		L	52	46	30	30	18 mm Solid Flat	4
	Saalt Soft		S	47	41	20	25	23 mm Solid Flat	2
Sckoon Cup	Saalt Soft		L	52	46	30	30	18 mm Solid Flat	2
	Sckoon Cup		S (1)	40	40		23	30 mm Thin Soft Taper	1
	Sckoon Cup		L (2)	50	45	29	30	20 mm Thin Soft Taper	1
	Selena		S	45	39	15	21	13 mm Ring	4
Selena	Selena		M	48	42	20	26	14 mm Ring	4
	Selena		L	53	45	25	33	14 mm Ring	4
Shecup	Shecup		OS	54	44		28	5.5 mm Knob	N/A
	Si-Bell		S	47	41	20	20	27 mm Solid Thin Notched	1
Scarlet	Si-Bell		L	52	46	30	30	22 mm Solid Thin Notched	1
	Scarlet		S	47	41		25	27 mm Solid Flat	TBD
Super Jennie	Scarlet		L	51	43		30	22 mm Solid Flat	TBD
	Super Jennie		S	48	43	26	32	9 mm Stem	1
Tampax	Super Jennie		L	52	47	34	41	16 mm Stem	1
	Tampax		S	42	47	20	24	23 mm Flat Solid	4
Tietucup	Tampax		L	47	53	30	37	16 mm Flat Solid	4
	Tietucup		S	46	38	23	32	24 mm Flat Solid	3
Ultu Cup	Tietucup		L	50	43	30	42	22 mm Flat Solid	4
	Ultu Cup		Mini	53	42	21	25	8 mm Solid Thin	4
	Ultu Cup		S	62	42	25	30	8 mm Solid Thin	3
Venus	Ultu Cup		L	62	46	30	40	8 mm Solid Thin	3
	Venus		S	47	42	23	29	24 mm Solid	3
XO Flo	Venus		L	56	47	39	47	15 mm Solid	3
	XO Flo		OS	55	45	38	38	31 mm Ball Taper	4
Yuuki	XO Flo		Mini	45	41	25	31	29 mm Ball Taper	4
	Yuuki		S (1)	49	42	20	25	18 mm Hollow Round	5
	Yuuki Soft		L (2)	56	47	33	37	18 mm Hollow Round	5
	Yuuki Soft		S (1)	49	42	20	25	18 mm Hollow Round	4
	Yuuki Soft		L (2)	56	47	33	37	18 mm Hollow Round	4

Appendix F – More about gender

1.1.6 WHAT IS GENDER?

THE GENDERBREAD PERSON

Before diving into why gender is important in relation to menstruation, some definitions will first be explained. The visual in figure xx is called the Genderbread Person (source: genderbreadperson.com), this depicts the differences in gender, attraction and sex.

Anatomical sex refers to a person's biological status and is typically assigned at birth, usually on the basis of external anatomy. Sex is typically categorized as male, female or intersex.

Gender is defined as a social construct of norms, behaviours and roles that varies between societies and over time. Gender is often categorized as male, female or nonbinary.

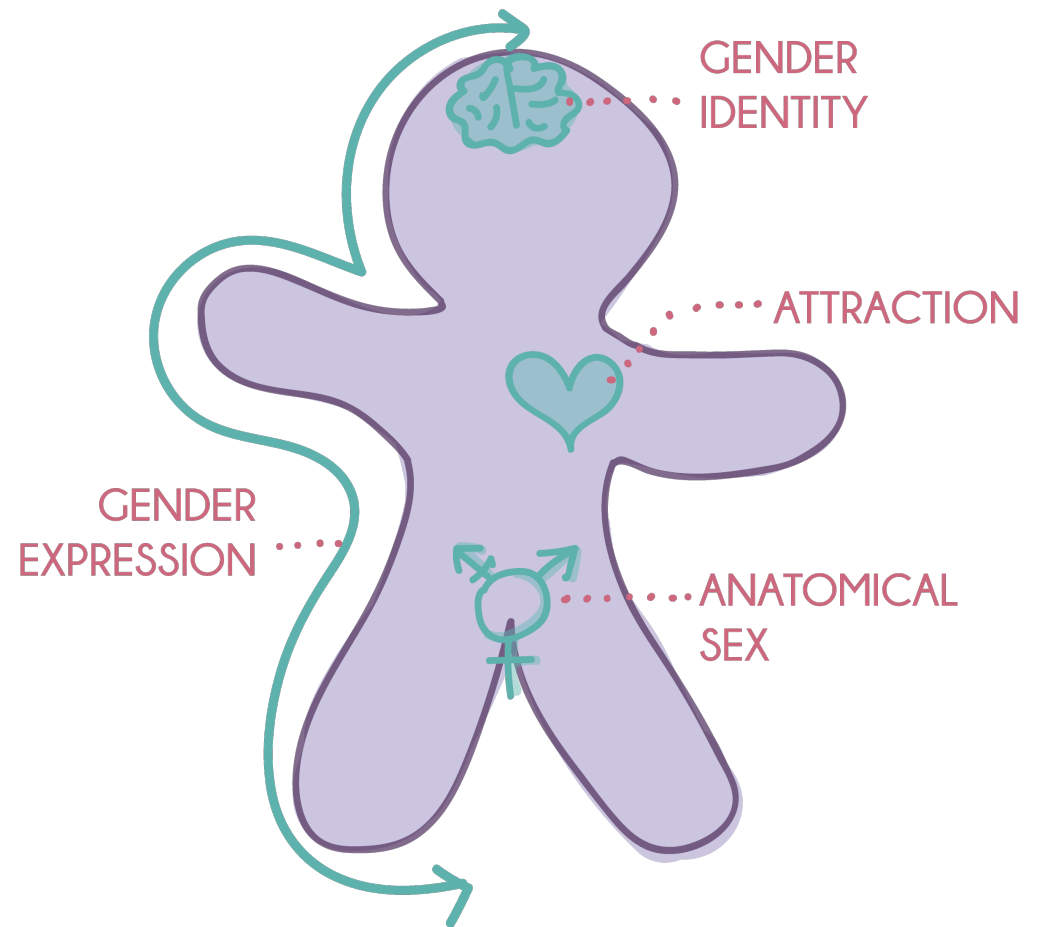
Gender identity is one's own internal sense of self and their gender, whether that is man, woman, neither or both. For most people, gender identity aligns with their sex assigned at birth (cisgender). However, for transgender people, gender identity differs in varying degrees from the sex assigned at birth. By definition, non-binary people are under the trans umbrella too.

Gender expression is how a person presents gender outwardly, through behaviour, clothing, voice, gender pronouns, or other perceived characteristics.

Attraction refers to the physical, romantic and/or emotional attraction to members of the same and/or other genders.

GENDER IDENTITY ≠ GENDER EXPRESSION ≠ ANATOMICAL SEX

GENDER ≠ SEXUAL ORIENTATION



Appendix G – Questions of in depth interview

So first I will ask some basic questions, then more about the current menstrual products, your experience with them, also your needs and at last some variables that influence the products.

1.1.7 DEMOGRAPHICS

- Wat is jouw leeftijd? / What is your age?
- Wat is jouw nationaliteit? / What is your nationality?
- Heb je nog een cyclus? / Do you still have your cycle?
- Gebruik je iets van **anticonceptie** of iets dat invloed heeft op je cyclus? / Do you use anything of contraception that has an influence on your cycle?
- Ben je zwanger geweest of kinderen gebaard? / Have you ever been pregnant and delivered a baby?

1.1.8 CURRENT PRODUCTS INTERVIEWEE USES



- Welke **producten** gebruik je wanneer je ongesteld bent (merk, grootte, materiaal, vleugeltjes met/ zonder)? / Which products do you use when you have your period? (brand, size, material, ..)
 - Heb je die altijd al gebruikt? Zo niet, wat is de reden dat je bent veranderd? / Did you always use those? If not what is the reason you changed?
 - Zijn er momenten wanneer je voorkeur verandert? Bv. Vakantie, zwemmen, of tijdens je menstruatie zelf, ... / Are there moments that your preference changes? For example, on vacation, at the sauna, while swimming, heavy/light flow, ...

PADS

- Wat zijn volgens jou voordelen en nadelen bij maandverbanden? / What do you find to be advantages and disadvantages of pads?
- Heb je ooit al herbruikbare maandverbanden gebruikt? Waarom wel/niet? / Did you ever use reusable pads? Why?

TAMPONS

- Wat zijn volgens jou **voor en nadelen** aan de **tampon**? Denk aan vorm, textuur, ... / What do you find to be advantages and disadvantages of tampons?
- Wat vind je niet fijn bij het insteken en uithalen van een tampon? / Is there something you do not like while inserting or changing a tampon?
- Gebruik je een applicator? Waarom? / Do you use an applicator? Why?
- Er bestaan herbruikbare tampons die bestaan uit een **lapje katoen** stof dat je moet oprollen en inbrengen, wat vind je hiervan? / There exist reusable tampons that are made from a strip of cotton that is rolled up and inserted, what do you think of this?



- Ben je soms bang om een **tampon** te **verliezen**? / Are you or have you been afraid to lose a tampon in your body?
- Wat vind je van het touwtje aan een tampon? / What do you think of the string of a tampon?
 - Hoe zou je liever hebben dat het eruit ziet? Meer esthetisch waardoor je trots bent om het te dragen of liever subtiel zodat het niet te zien is? / How would you like that it looks like? More esthetically pleasing where you can be proud of or something more subtle?

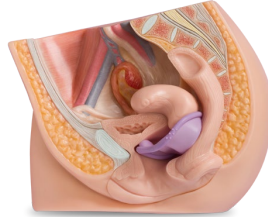
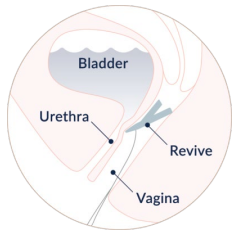
MENSTRUAL CUP

- Weet je wat een menstruatiecup is? *uitleg geven* / Do you know what a menstrual cup is? [insert image cups & position in vagina]
 - Heb je die ooit al eens gebruikt? Waarom wel/niet? / Have you ever used it before? Why?
 - Voor spiraal gebruikers: Stel dat je wel heftiger bloed zou je het dan wel willen uitproberen? / For IUD users: if your flow was heavier would you then want to use it?
 - In welk opzicht vind je dit anders dan een tampon? / In what way do you find this different than a tampon?
- Wat zijn volgens jou **voor en nadelen** aan de **cup**? Denk aan vorm, textuur, ... / What do you find to be advantages and disadvantages of cups?
- Wat vind je van het idee dat bloed wordt **opgevangen** in plaats van **geabsorbeerd** zoals bij een maandverband of tampon? / What do you think of the idea that blood is collected instead of absorbed like with pads or tampons?
 - Wat vind jij ervan dat de menstruatiecup en de menstruatiedisk de enige herbruikbare en bloedopvangende menstruatieproducten zijn die worden ingebracht? / What do you think of the menstrual cup and disc being the

only reusable, insertable and blood collecting menstrual products on the market?

OTHER PRODUCTS?

- Gebruik je nog **andere producten** die je in je vagina plaatst (voor korte of lange tijd)? Denk aan anticonceptie, ondersteuning van de blaas, of seksspeeltjes / Are there other products you use that are inserted into the vagina (for short or long period of time)? Like anticonception, bladder support, sextoys,...



- Wat vind je aangenaam of niet aangenaam aan die producten? (denkend materiaal/vorm) / What do you like or don't like about these products? (thinking of material/form)
- Mis je soms iets? Dat je denkt, moest dat er zijn dan zou dit product nog 100x beter zijn. / Do you miss something?

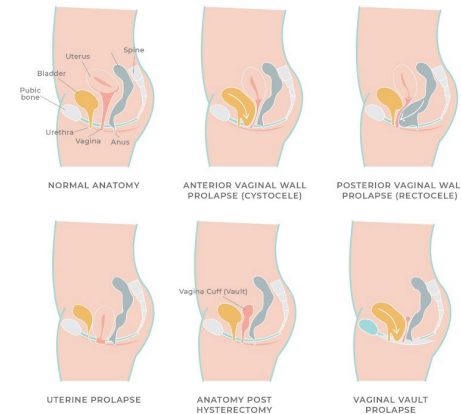
1.1.9 USER EXPERIENCE

- Zou je mij kunnen meenemen in hoe jij jouw menstruatie **ervaart**? In relatie tot het product? Is dit iets wat in je achterhoofd spelt of heeft het een grote impact op je dagelijkse leven? / Could you explain to you how you experience your period? Is this something that is in the back of your mind or that has a big impact on your day to day life?
- Wat vind je van het hele proces van kopen, meenemen, vervangen, ...? Welk onderdeel vind je het minst aangenaam? / How do you feel about the whole process of buying, taking it with you, changing, cleaning, ...? Which part do you like the least?
- Ondervind je soms problemen met **groottes**? / Do you experience problems with sizes?
- Wat vind jij **intimiderend** aan een menstruatie product? Denk aan grootte, vorm, textuur, kleur, ... / What do you think is intimidating in a menstrual product? Size form texture, color
- Heb jij het gevoel dat geur een invloed heeft op jouw ervaring? / Do you feel like fragrance/smell has an influence on your experience?

UX CHILDREN

- Heeft dit effect gehad op de menstruatieproducten die je erna gebruikte? / Did delivering children have an influence on which products you would use afterwards?
- Ondervind je hier nog steeds effecten van? / Do you still experience effects from it? Prolapse?

- Heb je last van een verzakking? Wat voor effect heeft dat op jou? / Do you have a prolapse? What kind of effect those this have on you?



UX OWN BODY

- Hoe **comfortabel** voel jij je met je eigen lichaam en met jezelf aanraken op intieme plaatsen zoals de vulva en vagina? / How comfortable do you feel in your own body and with touching yourself on intimate places?
 - Is dat altijd zo geweest? / Has that always been like that?
 - Denk je dat je later nog comfortabeler zal voelen? / Do you think you will be even more comfortable in your body later on?
 - Seks tijdens menstruatie? / Do you have sex during your period?
 - Denk je dat de society invloed heeft op jouw zelfbeeld/oncomfortabel voelen? / Do you think society has a big influence on your self image and how comfortable you feel?

1.1.10 NEEDS

- Wat vind jij de drie **belangrijkste** dingen aan een menstruatieproduct? / What are the three most important parts about a menstrual product?
 - Zijn er producten die daar nu aan voldoen? Are there products that fulfill these needs?
- Hoe ziet een **slecht product** er volgens jou uit? Stel alles eraan is echt het tegenovergestelde van wat jij wilt? / From your view, how does a really bad menstrual product look like? As in imagine that everything is the opposite of what you want?
 - Nog andere dingen waar je totaal niets van moet weten? / Other parts you really do not like?
- Stel je zou een **ideaal product** voor je hebben hoe zou dat werken en eruit zien/voelen,...? Met technologieën die mss nog niet bestaan, laat je fantasie de vrije loop / Imagine your ideal menstrual product, how would that look like, how would it feel, ...? Which technologies would it use, they don't have to exist, let your imagination run wild!
- Wat zou je vinden van een **nieuw product** dat bloed opvangt zoals een menstruatiecup maar dat dezelfde grootte heeft als een tampon en makkelijk uit te halen is door middel van een touwtje/uitsteeksel? / What would you think of a new product that collects blood like a menstrual cup but has the same size of a tampon and is easy to retract due to an external part?

1.1.11

1.1.12 VARIABLES INFLUENCE

- What do you find important in terms of sustainability, price, esthetics, femininity, hygiene, subtlety and fragrance?
- Denk jij aan **duurzaamheid** bij het aanschaffen van menstruatieproducten? / Do you think about sustainability when buying menstrual products?
 - Zou je graag duurzamer willen zijn? Waarom wel/niet? / Would you like to be more sustainable? Why?
 - Denk je dat er een behoefte is aan meer duurzame menstruatieproducten? / Do you think there is a need for more sustainable menstrual products?
- Wat zou je **duur** vinden voor een herbruikbaar product dat 5 tot 10 jaar meegaat? / What would you consider as expensive when thinking about a reusable product that could be used 5 to 10 years?
- Hoe belangrijk vind je uiterlijk/kleur van een menstruatieproduct? / how important do you find appearance and color of a product?
- Wat vind je belangrijk qua hygiëne? / What do you find important in terms of hygiene?

1.1.13 INFORMATION INTERVIEWED

PEOPLE # Age	📍 National...	💊 Anticonception	📋 Products	👶 Birth
21	Belgian	No	Liners Pads Tampons	✗
22	Belgian	Hormonal IUD	Tampons Pads Liners	✗
22	Spanish	The Pill	Pads Cup	✗
25	Dutch	No	Tampons Liners	✗
28	Colombian	No	Cup Tampons	✗
31	Mexican	No	Pads Cup	✗
34	Dutch	No	Tampons Pads	👶 👶

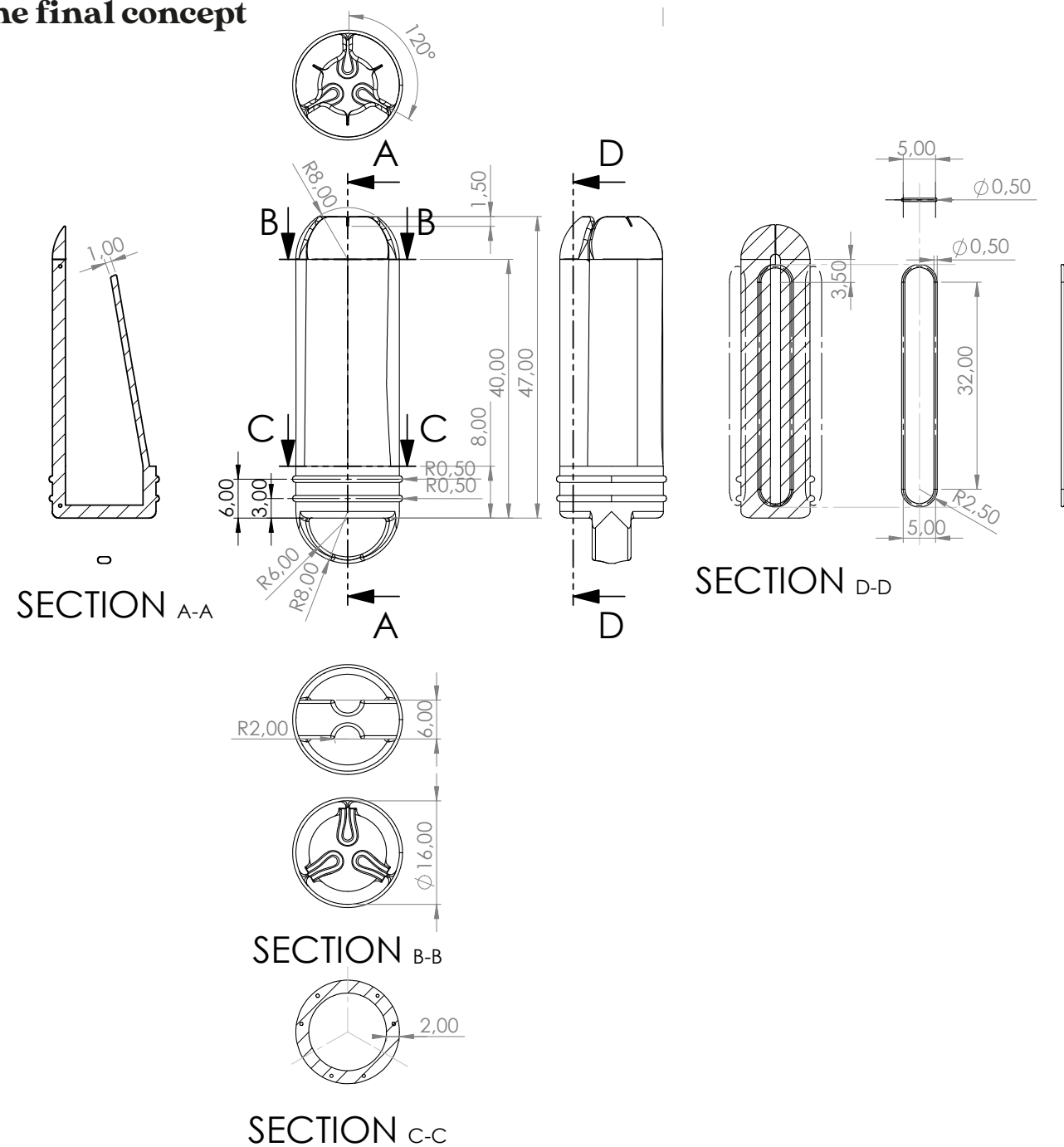
Appendix H – Material properties Silicone vs TPU vs TPV (Source: Granta Edupack)

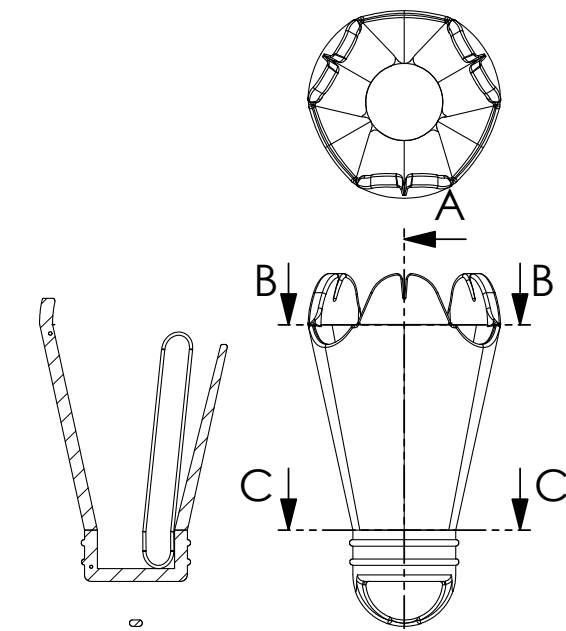
	Silicone (VMQ, heat cured, 10-30% fumed silica)	Silicone (VMQ, thermally conductive, 40-70% mineral)	TPU (Ester, aromatic, Shore A70)	TPV (PP+EP(D)M, Shore A55)	TPV (PP+EP(D)M, Shore A70)
Hardness - Shore A	47,4	77,1	70,7	54,8	69,8
⌵ Durability					
Water (fresh)	Excellent	Excellent	Excellent	Excellent	Excellent
Water (salt)	Excellent	Excellent	Excellent	Excellent	Excellent
Weak acids	Excellent	Excellent	Limited use	Excellent	Excellent
Strong acids	Excellent	Excellent	Unacceptable	Excellent	Excellent
Weak alkalis	Excellent	Excellent	Acceptable	Excellent	Excellent
Strong alkalis	Excellent	Excellent	Unacceptable	Excellent	Excellent
Organic solvents	Acceptable	Acceptable	Limited use	Limited use	Limited use
Oils and fuels	Limited use	Limited use	Acceptable	Unacceptable	Unacceptable
ASTM D2000 oil resistance class	E (80%)	E (80%)			
ASTM D2000 heat resistance type	F (200°C / 392°F)	F (200°C / 392°F)			
Oxidation at 500C	Unacceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable
UV radiation (sunlight)	Good	Good	Fair	Poor	Poor
Flammability	Self-extinguishing	Self-extinguishing	Slow-burning	Highly flammable	Highly flammable
Oxygen index (%)	27 - 35	40 - 42	21 - 25	17 - 20	17 - 20
Chemical resistance					
Water (distilled)	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory
Water (sea)	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory
⌵ Primary production energy, CO2 and water					
Embodied energy, primary production (virgin grade) (MJ/kg)	124	72,3	121	121	121
Embodied energy, primary production (typical grade) (MJ/kg)	124	72,3	121	121	121
CO2 footprint, primary production (virgin grade) (kg/kg)	6,51	3,85	5,73	6,03	6,03
CO2 footprint, primary production (typical grade) (kg/kg)	6,5	3,85	5,73	6,03	6,03
Water usage (l/kg)	329	329	335	281	281

	Silicone (VMQ, heat cured, 10-30% fumed silica)	Silicone (VMQ, thermally conductive, 40-70% mineral)	TPU (Ester, aromatic, Shore A70)	TPV (PP+EP(D)M, Shore A55)	TPV (PP+EP(D)M, Shore A70)
Processing energy, CO2 footprint & water					
Polymer extrusion energy (MJ/kg)			6,09	6,16	6,17
Polymer extrusion CO2 (kg/kg)			0,457	0,462	0,463
Polymer extrusion water (l/kg)			5,89	5,93	5,94
Polymer molding energy (MJ/kg)	14,8	14,8	18,8	20,8	20,9
Polymer molding CO2 (kg/kg)	1,18	1,18	1,41	1,56	1,57
Polymer molding water (l/kg)	13,1	13,1	15	16	16
Grinding energy (per unit wt removed) (MJ/kg)	2,43	0,876	8,17	0,996	1,5
Grinding CO2 (per unit wt removed) (kg/kg)	0,182	0,0657	0,613	0,0747	0,112
Recycling and end of life					
Recycle	✗	✗	✓	✓	✓
Embodied energy, recycling (MJ/kg)			41	41,2	41,2
CO2 footprint, recycling (kg/kg)			1,95	2,05	2,05
Recycle fraction in current supply (%)	0,1	0,1	0,1	0,1	0,1
Downcycle	✓	✓	✓	✓	✓
Combust for energy recovery	✓	✓	✓	✓	✓
Heat of combustion (net) (MJ/kg)	13,7	5,85	23	45,1	45,1
Combustion CO2 (kg/kg)	1,33	0,572	2,05	3,14	3,14
Landfill	✓	✓	✓	✓	✓
Biodegrade	✗	✗	✗	✗	✗
Price					
Price (EUR/kg)	3,39	2,66	4,1	2,94	2,94
Price per unit volume (EUR/m ³)	3790	5920	4800	2830	2820
Physical properties					
Density (kg/m ³)	1120	2220	1170	964	960

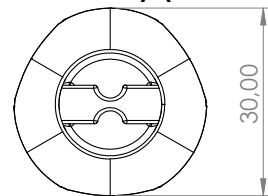
	Silicone (VMQ, heat cured, 10-30% fumed silica)	Silicone (VMQ, thermally conductive, 40-70% mineral)	TPU (Ester, aromatic, Shore A70)	TPV (PP+EP(D)M, Shore A55)	TPV (PP+EP(D)M, Shore A70)
⬅ Mechanical properties					
Young's modulus (GPa)	0,0158	0,0116	0,0138	0,0047	0,016
Specific stiffness (MN.m/kg)	0,0142	0,00522	0,0118	0,00487	0,0167
Yield strength (elastic limit) (MPa)	8,97	3,5	37,5	2	4
Tensile strength (MPa)	8,97	3,5	37,5	4,92	7,52
Tensile stress at 100% strain (MPa)	2,08		3,43	2,02	3,05
Tensile stress at 300% strain (MPa)			6,45	3,59	4,78
Specific strength (kN.m/kg)	8,03	1,57	32	2,07	4,17
Elongation (% strain)	402	84,9	725	411	485
Elongation at yield (% strain)	402	84,9	725	60	55
Compressive modulus (GPa)	0,0158	0,0116	0,0138	0,0047	0,016
Compressive strength (MPa)	10,8	4,2	44,9	2,4	4,8
Flexural modulus (GPa)	0,0158	0,0116	0,0138	0,008	0,0263
Flexural strength (modulus of rupture) (MPa)	19,1	10,8	61,3	13	16,9
Shear modulus (GPa)	0,00245	0,0122	0,00464	0,00158	0,00538
Shear strength (MPa)			33,5	4,4	6,72
Bulk modulus (GPa)	1,73	1,73	0,23	0,0784	0,267
Poisson's ratio	0,48	0,48	0,487	0,487	0,487
Shape factor	1,6	1,7	1,6	1,7	1,7
Hardness - Vickers (HV)	3,46	2	11	1	1
Hardness - Rockwell M			4,9	0,5	3,46
Hardness - Rockwell R			4,9	0,5	3,46
Hardness - Shore D		20,6	24,5	9,54	20,4
Hardness - Shore A	47,4	77,1	70,7	54,8	69,8
Elastic stored energy (springs) (kJ/m ³)	2540	527	50800	425	500
Fatigue strength at 10 ⁷ cycles (MPa)	3,59	1,4	15	1,97	3,01
Compression set at 23°C (%)	7,07	7,07	22,4	20	23,4
Compression set at 70°C (%)	7,07	7,07	43,6	27	35,9
Compression set at 100°C (%)	7,07	7,07		35	40,9
Tear strength (N/mm)	20	14,5	70,4	21,4	29,7

Appendix I - Dimensions of the final concept

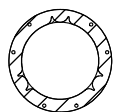




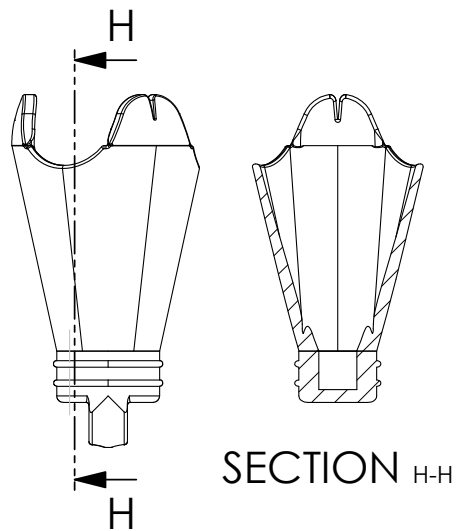
SECTION A-A



SECTION B-B



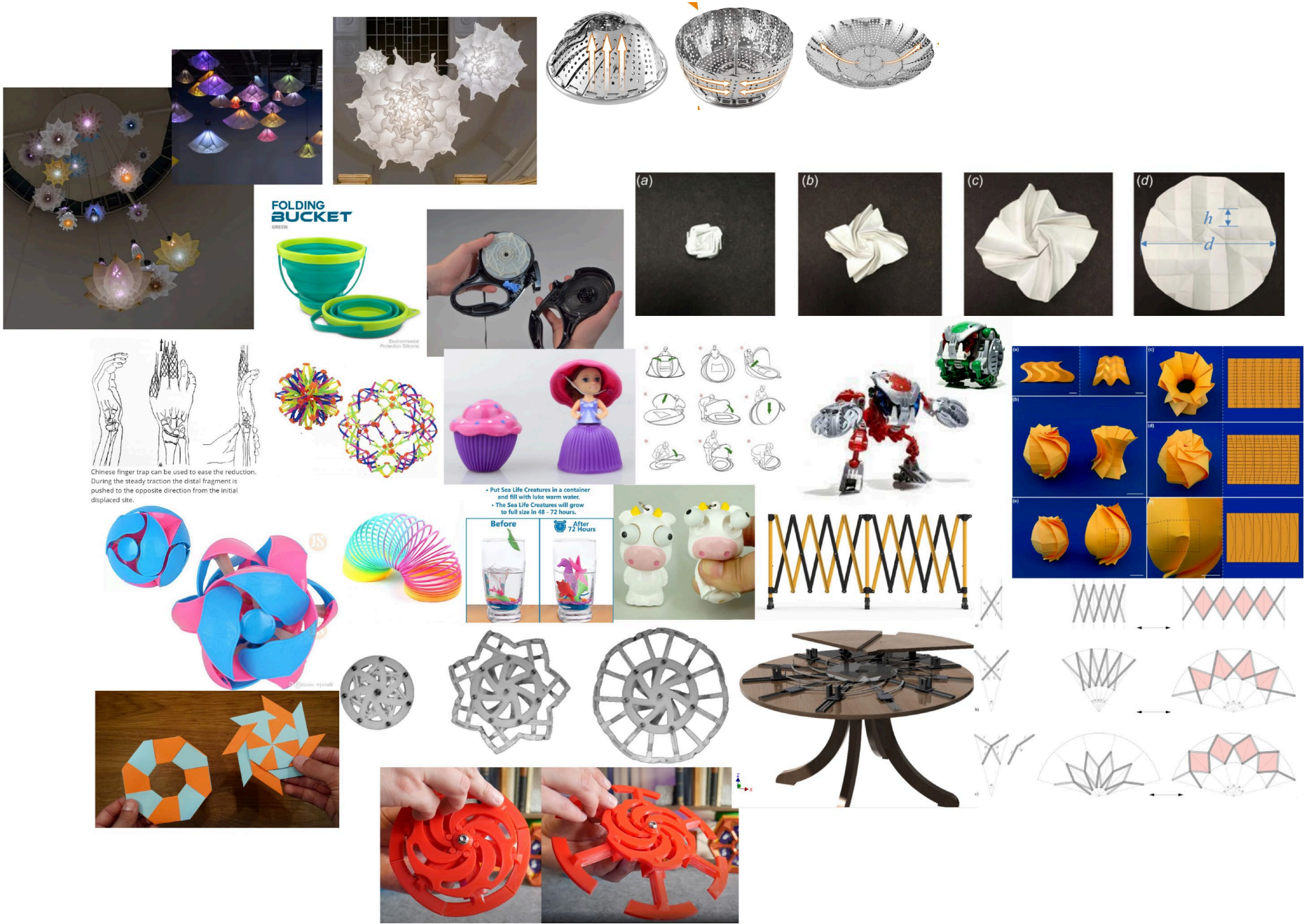
SECTION C-C



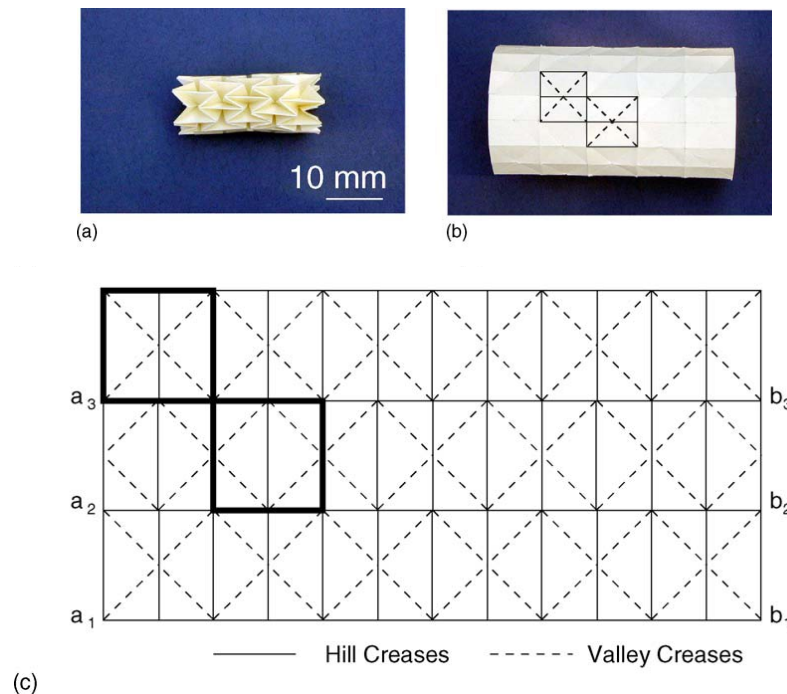
SECTION H-H

UNI	DR	C+	API	Mf	Q.
DIA					
SUP					
TOI					
LI					
A					

Appendix J - Collage of ways to deploy



Appendix K – Origami elaboration



1.1.1 ORIGAMI - KURIBAYASHI FOLD

A known way to deploy something is using origami. There are origami figures like a bird or a plane but origami techniques can also be used in the medical field. Kuribayashi developed a stent from shape memory alloy material (see X>X Fixme for more about SMA) to deploy and therefore adapt to the artery by combining it with an origami shape.

In Kuribayashi's paper (2006) about their stent graft (see Figure 1.10), the interesting properties of this folding pattern are explained. Firstly, due to the folds acting as hinges, it causes the stent graft to fold and deploy both longitudinally and radially. By folding, the diameter and length decrease, while they increase when deployed (Figure 8.1). Besides, the folded configuration of each element also makes the stent graft flexible.

Ni-rich TiNi foils were used because **martensitic transformation temperature** is adjustable to the temperature near human body by appropriate aging (Kuribayashi, 2006).

The Ni-rich TiNi SMA foils (50mm×100mm×0.05 mm) were etched to create grooves for the folds of the origami stent graft using a negative photochemical etching process (Kuribayashi, 2006). The foils were constrained by an aluminum tube during the aging (773K for 20–40 h).

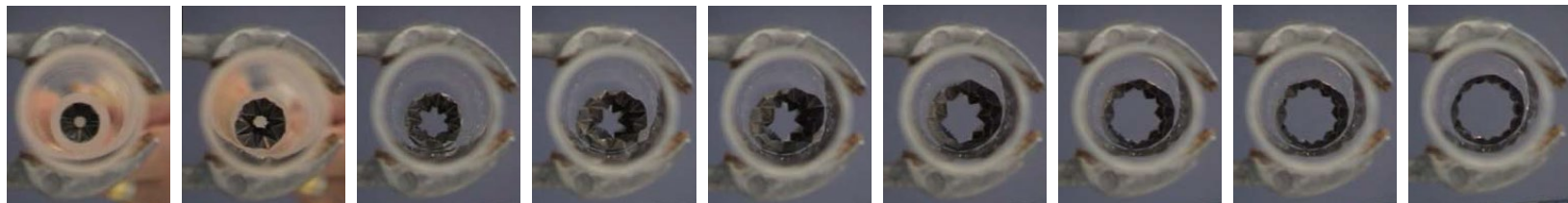


Figure 1.5 Series of frames from video recording showing self-deployment of the stent (end view): (a) stent graft which is folded and backed into a small acrylic tube of 13mm radius was inserted into another acrylic tube of 25mm radius and (b) the small acrylic tube was removed and (c-i) the stent graft was self-expanding at above A_f (319 K).

To know if this origami method could be of interest for my design, I replicated part of the origami pattern (Figure 8.3). Quite early on in making the shape it became clear that it is rather difficult to fold back into the right way. On a big scale this is still possible but translating this to a tampon sized product and knowing the user will have to fold it, this would be too complicated.



Figure 1.6 Self-made origami shape two by three shapes connected to each other to form a bigger one.

Appendix L – Brainstorm sessions

A first brainstorm session was done with two people from the target group. They both are AFAB and identify as women. Both have experience with a cup.

1.1.2 WARM-UP

First, an introduction about what will be done is given, also some rules are explained. We started with the 'Flower association' as a warm-up to get the brain in the mood of thinking of associations. 'Menstruation Products' was put in the center, the participants could then write down any word or idea that pops up into their mind, like petals of a flower (see Figure FIXME). After about 10 to 15 minutes most petals were filled and we discussed some words that they found to be interesting.

1.1.3 BRAINWRITING

The next exercise was to find solutions for the question written in the middle (see Figure FIXME). The questions were:

1. How can you make something adaptable to a form? (see Figure FIXME)
2. How can you not forget something? (see Figure FIXME)
3. How can you keep something in its place? (see Figure FIXME)

Everyone started with a different question and after 5 minutes, we switched to another question. This was repeated until they ended up with the question they started. Once this was done, we discussed the ideas with interesting potential and circled the ones we want to take with to the next exercise.

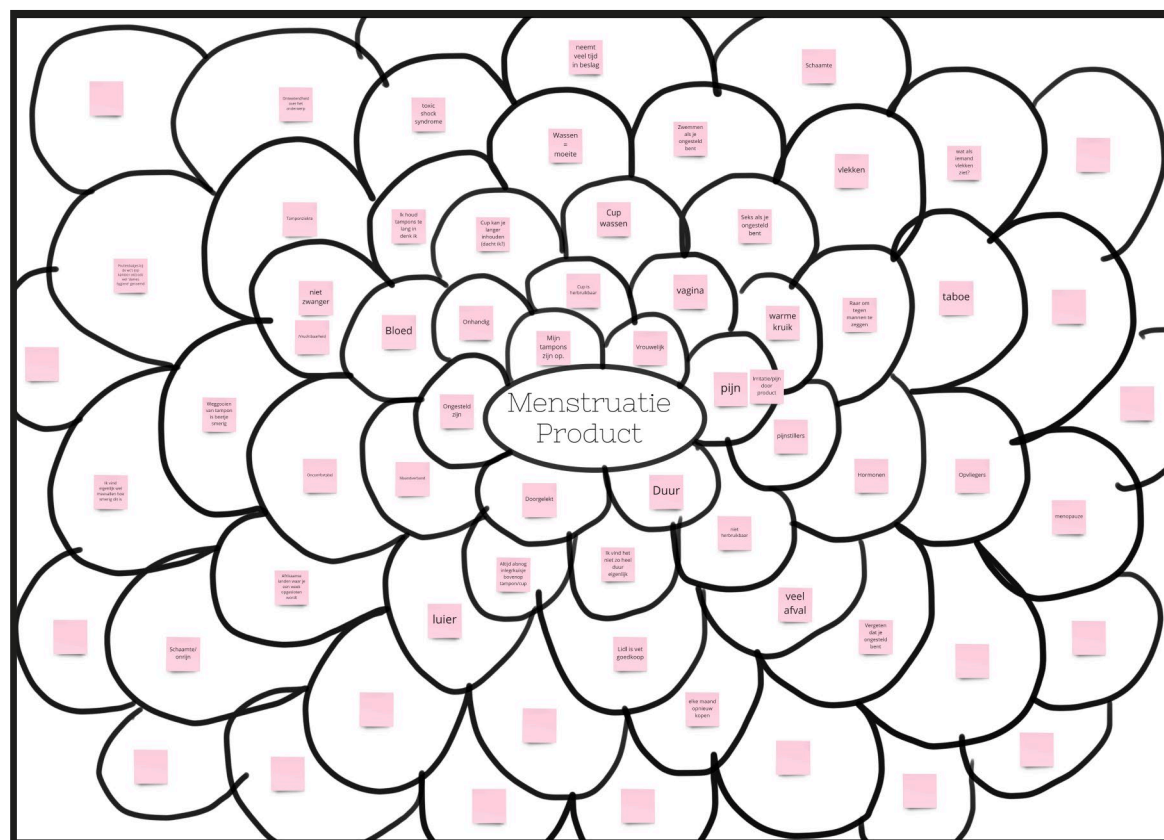


Figure 1.7 Warm-up Flower Association Brainstorm Session 1

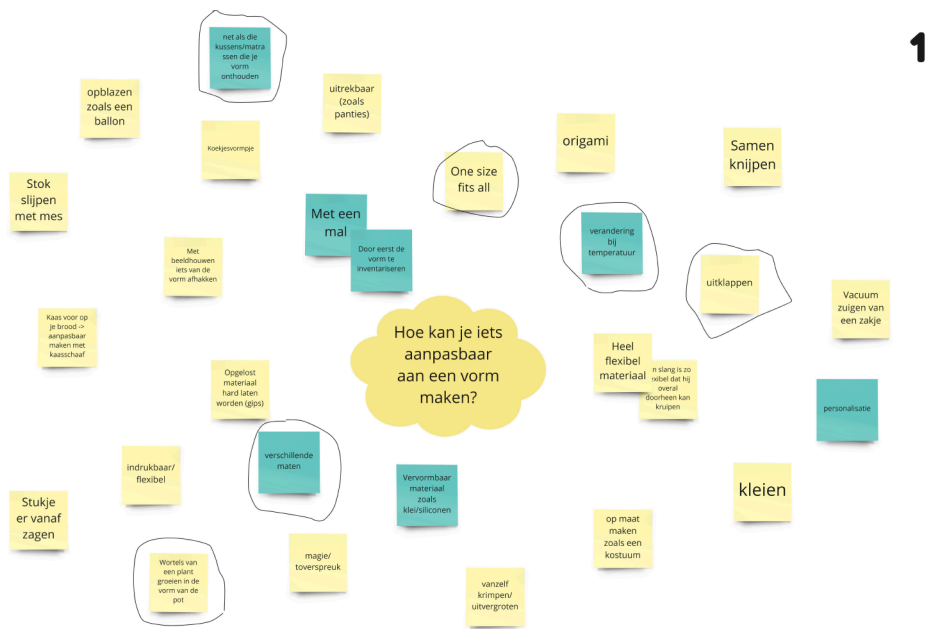


Figure 1.9 Question: How can you make something adaptable?

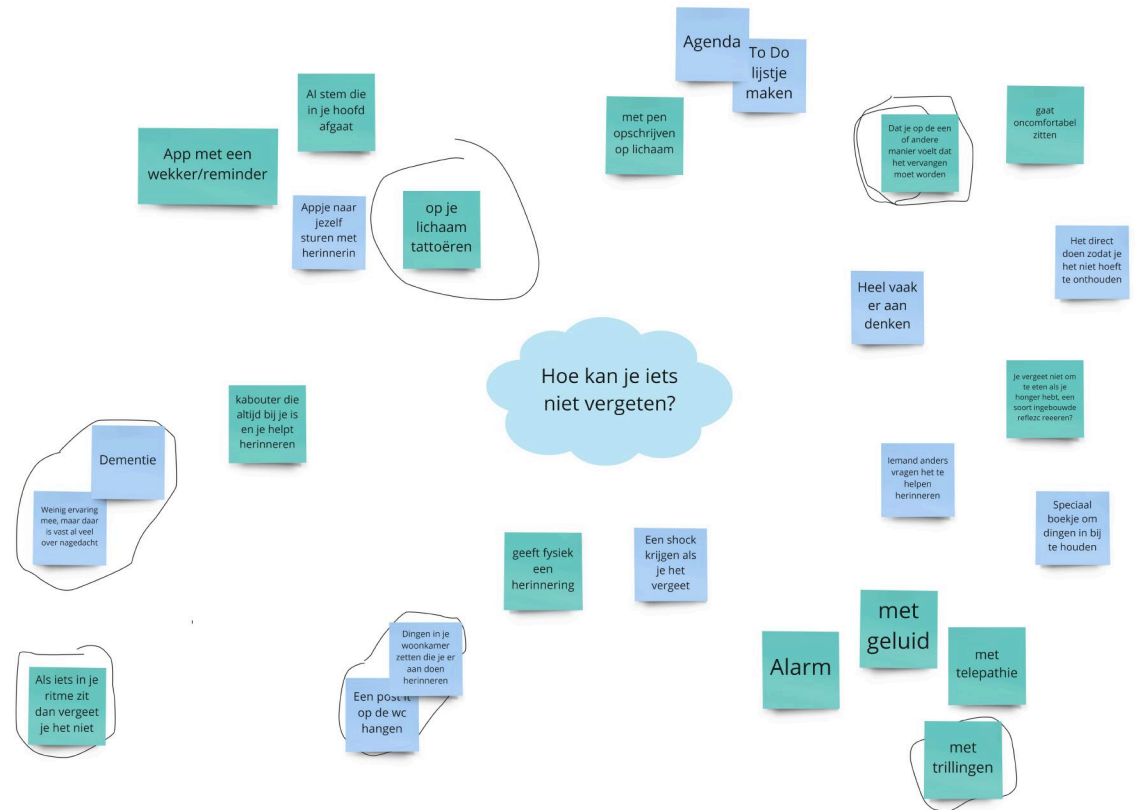


Figure 1.10 Question: How can you not forget something?

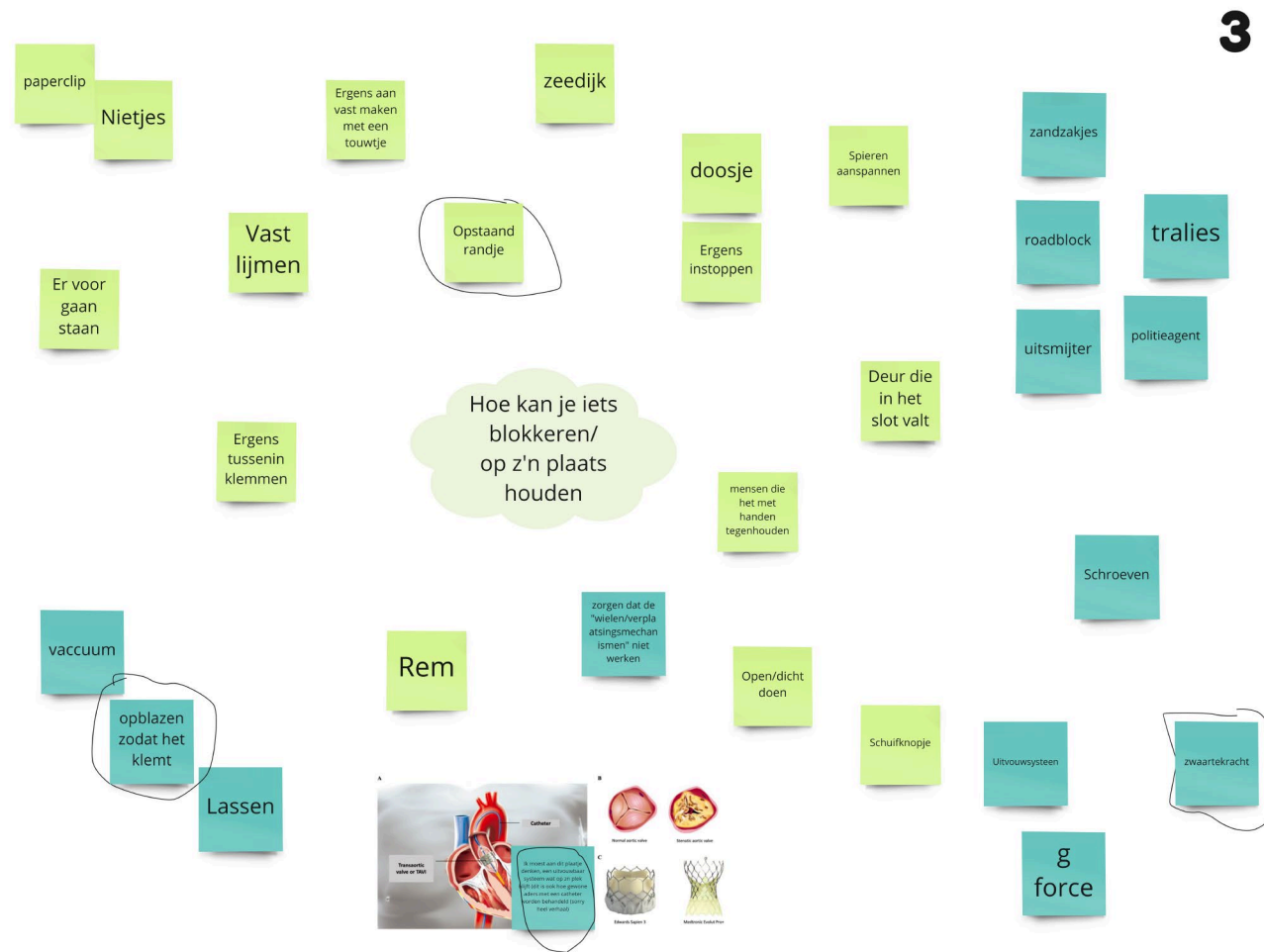


Figure 1.11 Question: How can you keep something in its place?

1.1.4 APPLYING IDEAS

The circled post-its were brought together to see how these could be applied to a menstrual product. Some interesting ideas came out of it. I will make drawings of them and decide which aspects could have potential for the design.

What was already remarkable to me were:

- making use of barbs to keep the product in place but by pulling something they would retract to take the product out/using friction to keep it in place
- a part on the outside that becomes bigger or shifts color to grab attention to change it
- making use of shape memory alloy to unfold the cup
- making a cup that fits you by making a mold of your vagina and pulling a shape memory alloy sleeve around it

Interesting to dive into:

- looking at tools for people with dementia, how do they not forget certain things?
- roots of plants adapt to their environment
- memory foam mattress or cushion
- blowing something up until it is blocked

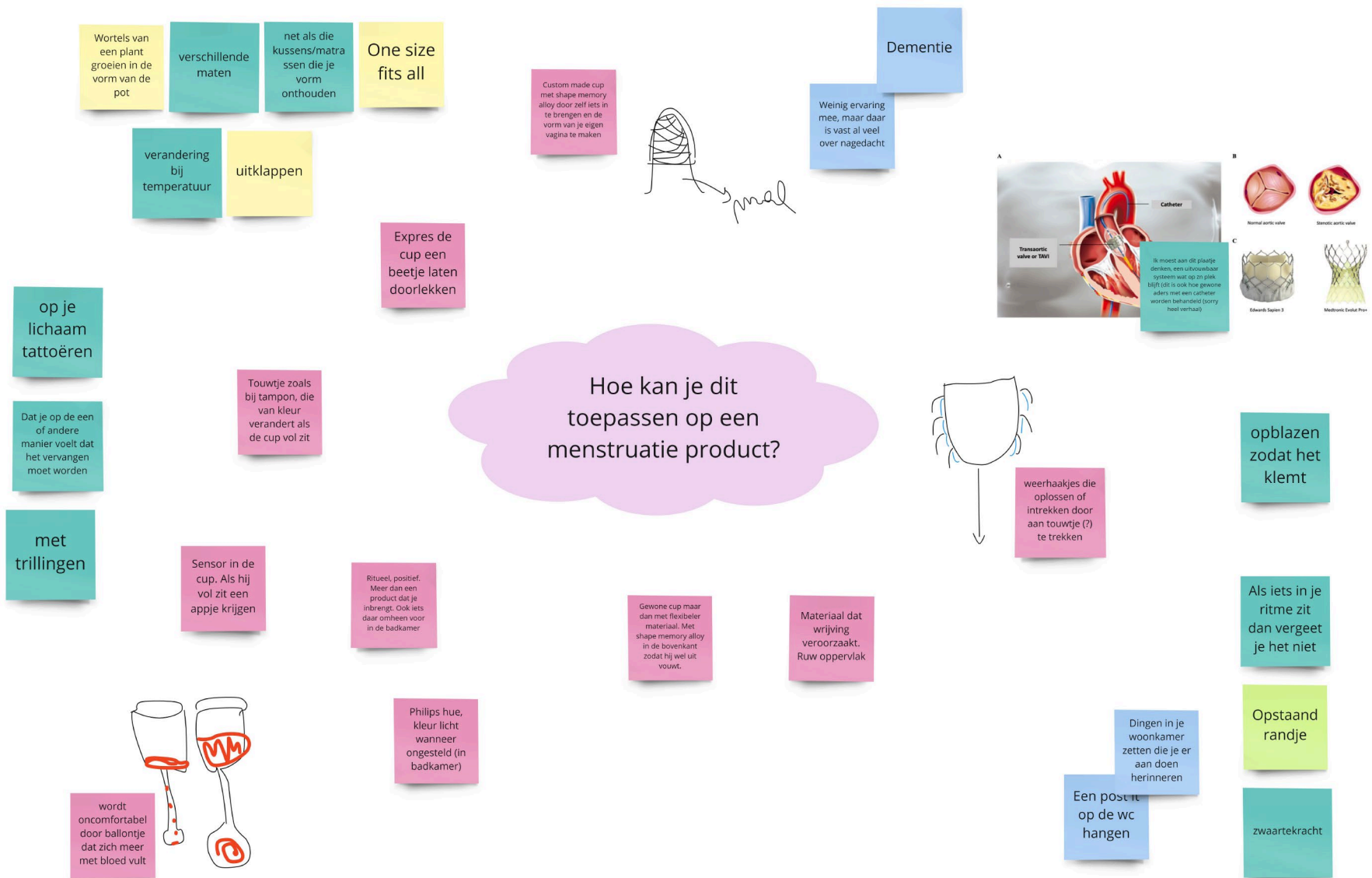
1.1.5 CONCLUSION

It did give me some new inspiration and ideas but it was apparent that my questions were too broad for where I wanted to get to. For a next brainstorm I will focus more on one thing and guide them more into the depth.

The combination of using Miro as a digital whiteboard and Zoom to talk with each other was great.



Figure 1.12 Brainstorm participants



A second brainstorm session was done after the first prototyping and testing was executed with silicones and SMA and its composite. A friend who graduated IPD joined me for the brainstorm, she is also part of the target group.

1.1.6 PROCESS

First I introduced her to the different shore hardness silicones, afterwards the SMA's and composites where shown how they worked in hot water. The collage of deployable mechanisms was displayed on my computer and some examples from biomimicry were given.

The goal of this brainstorm was to create ideas for:

1. The take out aid
2. Deploying the product without use of SMA
3. Deploying the product with use of SMA

While keeping in mind the needs and wants of the target group and the possibilities of the silicone and SMA materials.

The three subjects where put on A4 papers and ideas could be written on post-its and added to the right paper. A fourth paper was added for random ideas that could be helpful with anything related to the project.

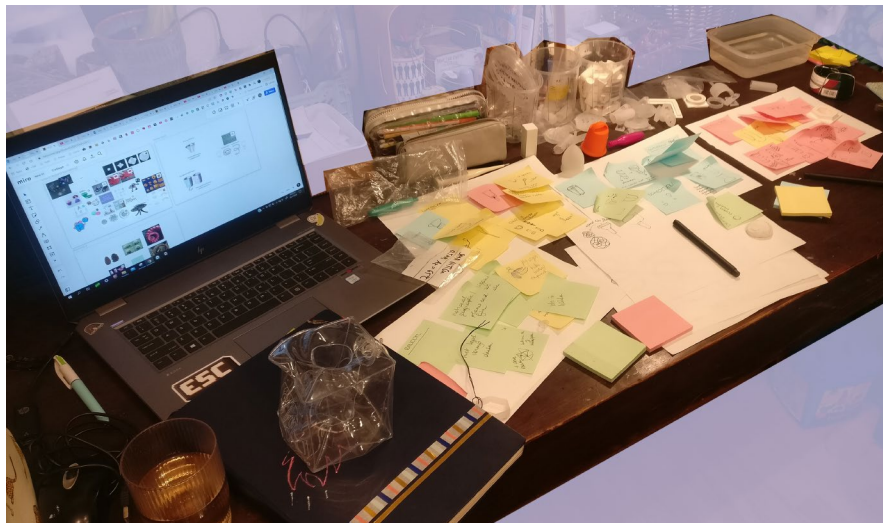


Figure 1.13 Brainstorm workplace



Figure 1.14 Random thoughts and ideas

1.1.7 DEPLOYING WITHOUT SMA

Most ideas were based on varying the thickness within the product to be able to fold the product to make it smaller. Other ideas are making use of the flexibility of silicone.



Figure 1.15 Deploying the product without use of SMA

1.1.8 DEPLOYING WITH SMA

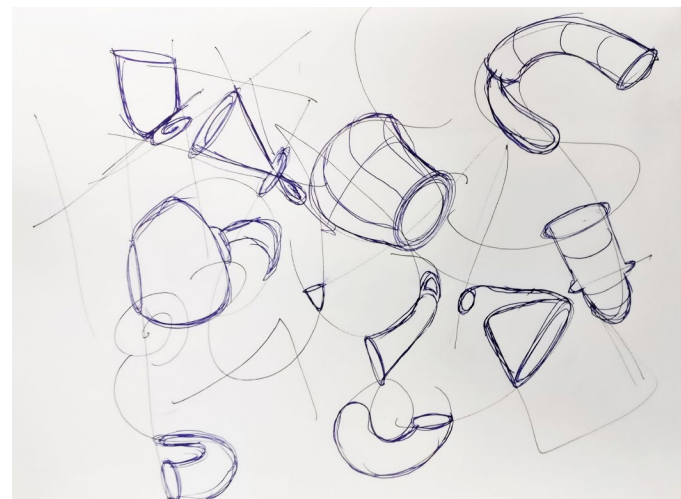
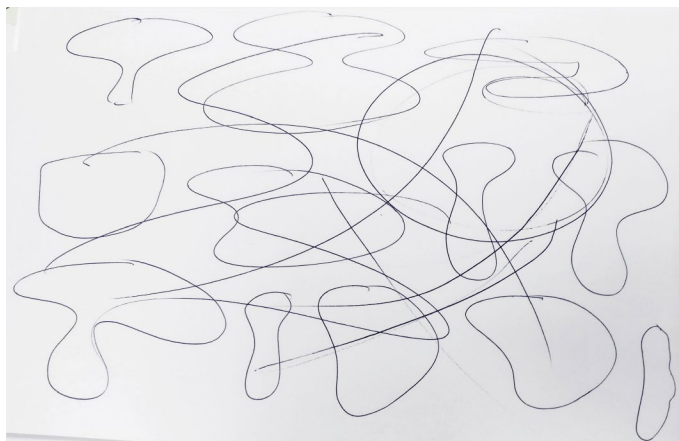
Looking into deploying with SMA ideas taking inspiration from an umbrella, a flower, and steamer basket came forward. Furthermore,



Figure 1.16 Deploying the product with use of SMA



Figure 1.17 The take out aid



Appendix M – Silicone extraction ideas

1.1.9 STRING AND LOOP IN ONE (1)

This idea can only be accomplished if the product can be turned inside out. This means the user can choose which take out aid they want to use each time (see Figure 10.3) . For example they want to go to the sauna and do not want anything showing on the outside, so they turn the product to the side where it the loop sticks out. On the inside (where the blood will also be collected) the string will be tucked away. Once they want to use the string again, they turn the product inside out. This is possible due to the flexibility of the silicones.



The user has the choice between loop and string



It can be difficult to turn inside out



It may wear out sooner due to turning inside out often

IN PRACTICE

Silicone prototypes were made from an idea with the help of an 3D printed mould. The string on the inside did not stay one piece because air bubbles got trapped (Figure 10.5). With a better mould design this could be resolved and it would be possible to both have a functional loop and string in one. The Enna Cup already has a silicone string (Figure 10.7) implemented.

Nevertheless, I did not account for the shape not being the same when turned inside out which can be seen in Figure 10.6. This method can only work when the product goes straight up. Once there are angles, these will be going the opposite way when turned inside out as happened with this prototype.

Can this be resolved and is it worth it to look into it? An option could be to use the straight shape as in Figure 10.3 to which parts are added both on the inside and outside which can act independently without making use of angles.

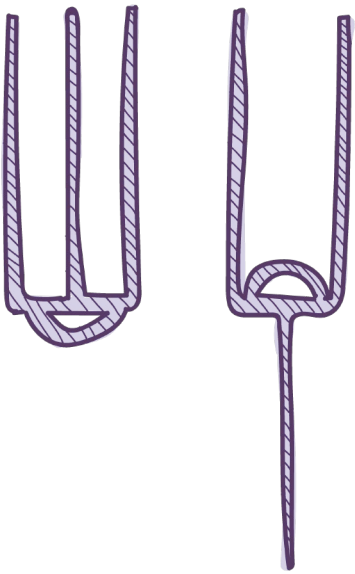


Figure 1.18 Take out aid idea string and loop in one by turning inside out



Figure 1.21 Take out aid idea string loop side



Figure 1.19 Take out aid string side



Figure 1.20 Take out aid string side top view



Figure 1.22 The Enna Cup, with silicone string

1.1.10 REMOVABLE STRING (2)

PRESS STUD DESIGN

Looking at the Flex cup (Figure 10.8), we know it is possible to have a removable string while making the product leak proof. In the case of the Flex cup the string can be pulled to break the vacuum. Furthermore, the string can move freely due to the hole at the bottom of the product. The string is attached to the upper rim of the cup so that it can be cleaned thoroughly without losing the string.

The idea of a removable string can be executed in two ways. Firstly, just like the Flex cup there is a hole where the string can go through, only this time it is secured like the principle of a press stud. This way the string is not attached to the product and can be used interchangeable with different lengths.





-  The user can choose the length they want
-  The strings could become customizable
-  Strings could become lost
-  If not attached right, leakage is possible



Figure 1.23 The Flex cup has a string to break the seal which can move freely due to the hole at the bottom of the product. It is attached near the rim as seen at the top right image (Image source: flexfits.com)

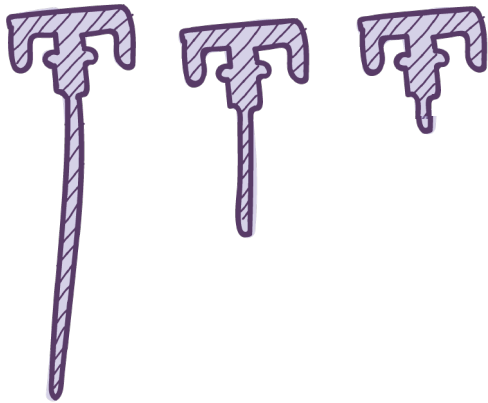


Figure 1.24 Different lengths of strings for one the user for example does not want something on the outside while going to the sauna

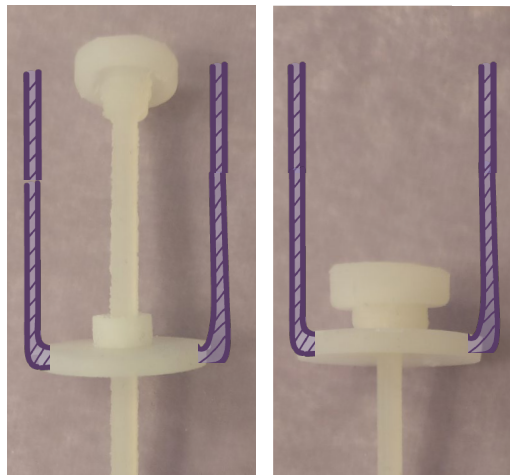
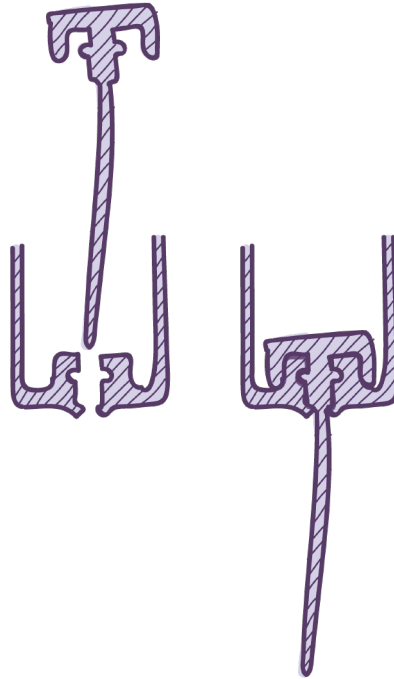


Figure 1.25 Removable string method 1 - securing it by replicating principle of a press stud

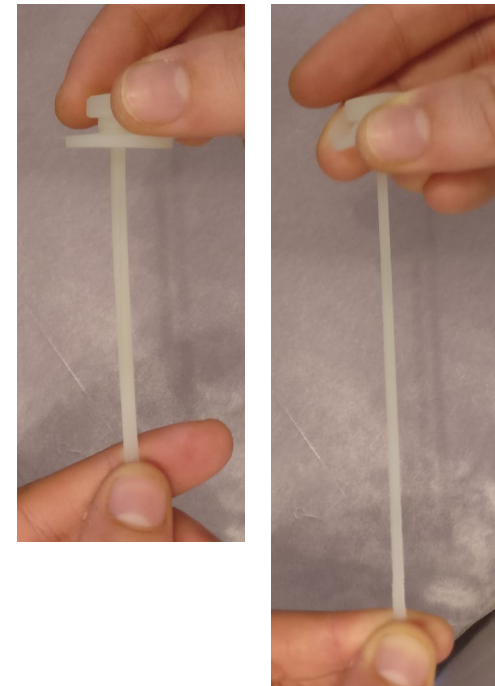


Figure 1.26 Testing if the string holds when pulling on it.

1.1.11 SPIRAL STRING (3)

As said before users want to know they can easily take out the product, they do not (always) want a visual clue on the outside but they also do not want to forget having something inside. So thinking about a compromise of these, lead me to the shape of a spiral. Due to its shape it will not go in unwanted directions, but it is still the length of a normal string.

The spiral can be attached to the product in two manners:
1) the middle is attached to the bottom (Figure 10.17), a consequence could therefore be that the end of the spiral is the loop of the bigger diameter so it could stick out more
2) the end on the outside is attached to the bottom of the product (Figure 10.18), therefore the end in the middle will be what sticks out of the vulva, its diameter depends on how much of the string is inside.

- + It is attached to the product
- + It does not go to unwanted directions, perfect for swimming/sauna
- + Length could be adjusted by cutting a piece of
- Could be too bulky and be felt
- Is not recognisable from a regular tampon
- Length can only be adjusted once by cutting it

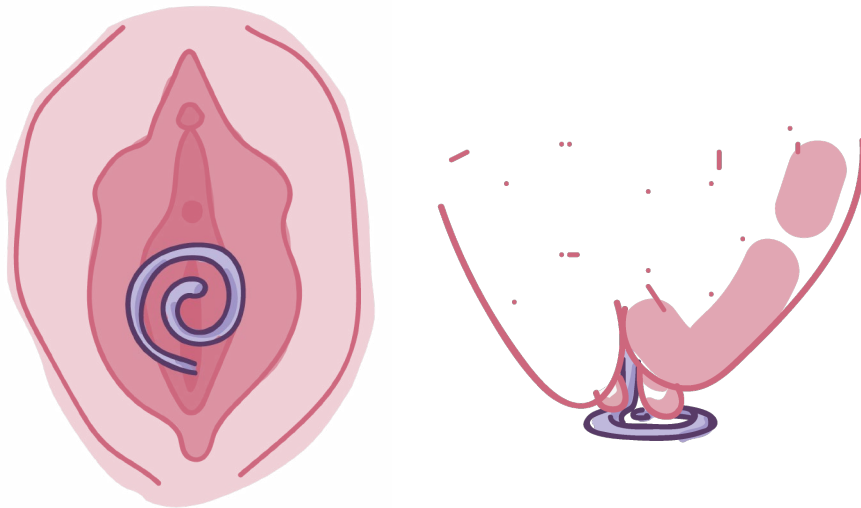


Figure 1.27 Spiral string manner 1. Silicone model with improvised clay mold (left). Silicone model with 3D printed mold (right).

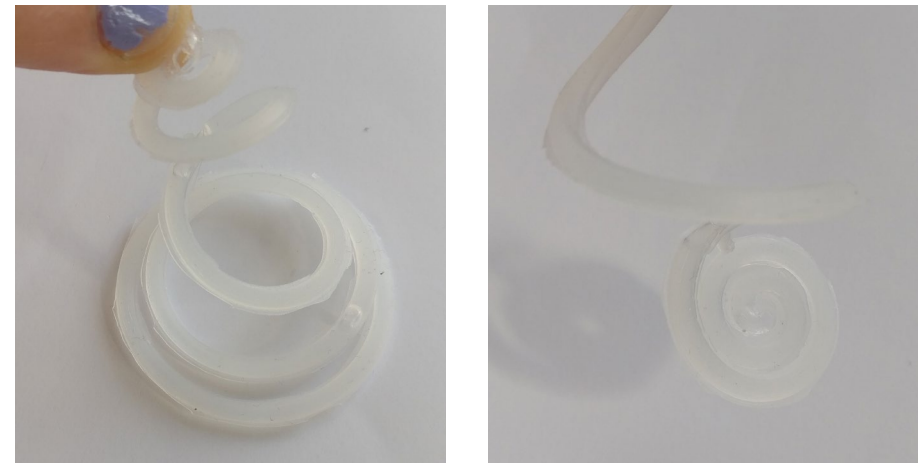


Figure 1.28 Spiral string manner 2. Silicone model with improvised clay mold (left). Silicone model with 3D printed mold (right).



Appendix N – Question of evaluation interview regarding the perception and impression of the product

Which category suits them?

What is your age?

As what do you identify your gender?

IN GENERAL

Do you use contraception at the moment?

Do you still have your cycle?

Which products do you use during your period?

What holds you back from getting a cup?

How did you choose your menstrual products at the moment

FIRST IMPRESSION OF THE HOLLOW TAMPON

How recognizable is the product as a menstrual product on a scale from a single use tampon to a menstrual cup.

What comes to mind when seeing a menstrual cup and knowing that you have to insert it?

Sort the products from least intimidating to insert to most intimidating to insert

MATERIALS & TECHNICALITIES

How do you think the product works?

Now that you know its mechanism, how do you feel about the product?

EXTRACTION

How do you experience extracting a tampon?

How do you think extracting would be with using a cup?

Do you sometimes forget you have a period product inside you?

What do you think you would use to extract the hollow tampon? And does it depend on something like mood, flow, location?

What do you think of having the possibility to choose? Would this work for you?

Would you rather have less capacity but more comfort with inserting and extracting or the other way around?

Do you think this is a possible realistic sustainable alternative of the single use tampon?

What do you think of the name Beppy Clover, what do you associate it with?