UNIVERSIDADE D
COIMBRA

Maria de Nolasco Santos

ADAPTIVE FASHION AND DIGITAL TECHNOLOGIES IN POST MASTECTOMY

UNDERGARMENT PERSONALIZATION AS A WAY OF EMPOWERING WOMEN

Dissertation in the context of the Master's in Design and Multimedia advised by Professor Paula Alexandra Silva and presented to the Faculty of Sciences and Technology / Department of Informatics Engineering of the University of Coimbra.

January 2023

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Faculty of Science and Technology of
University of Coimbra

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Agradecimentos

À minha orientadora,
Por ter aceite embarcar neste projecto, por ter compartilhado o entusiasmo pelo tema da dissertação e pela disponibilidade demonstrada.

Às minhas amigas e colegas de Mestrado, em especial o Eduardo,
Pela ajuda essencial no desenvolvimento desta dissertação, pelas explicações e pela partilha de conhecimento. Ana Sofia, Diva, Beatriz, Valéria, Irina e Bárbara, as que conseguiram tornaram estes dois anos mais animados.

À Rádio Universidade de Coimbra,
Por me ter mostrado um hobbie novo, que tantas vezes serviu como escape durante este percurso. Pelas amizades que me deu, e pelo espaço em que tantas horas passei lá a trabalhar.

Aos meus amigos Samuel e Inês,
Por estarem sempre disponíveis a ouvirem os meus desabafos e a ajudar-me da melhor forma que conseguiram.

Aos meus pais e ao meu irmão,
Pelo apoio incansável ao longo de todo o meu percurso académico, e a encorajarem-me a continuar este projecto.

A todas as mulheres que contribuíram neste projecto,
Sem estas, a dissertação não seria metade do que é. A partilha desta experiência tão pessoal, de forma tão leve e aberta, foi a chave para o desenvolvimento deste projecto. Obrigada por me mostrarem a encarar as advertências da vida de forma positiva, e sempre com um sorriso.

Abstract

Women who have undergone mastectomies face various changes and go through a number of struggles, both physically and psychologically. This may lead to the loss of their sense of femininity and self-esteem. One particular challenge that women who have undergone mastectomies face emerges from the lack of undergarment options that are adapted to their specific needs, whilst being fashionable. The right undergarment options could help tackle the negative consequences of their condition and positively influence their mental state and sense of inclusion. Adaptive fashion may afford us a way to contribute to solving this problem, having the potential to revolutionize the fashion industry. This dissertation reports on the design, development, and evaluation of a proof of concept of an app that allows women who have undergone mastectomies to virtually try a bra and personalize it according to their preferences. To develop this work, a set of activities was carried out. Eight interviews were carried out with four women who had undergone a mastectomy and four health professionals. The four women also participated in a photo elicitation activity. Having gained a deeper insight into the context of the problem and the needs of women who have undergone mastectomies, a 3D bra model and prototypes of increasing fidelity of the proof of concept were created. The final prototype was evaluated through usability testing and two self-reporting post session questionnaires with eight participants. The results of the usability tests showed that the proof of concept is easy to navigate and use. This was confirmed by the results of the post session questionnaire, which revealed an unanimous positive response towards the proof of concept. We hope this work contributes not only to improving the life of women who have undergone a mastectomy and other women with similar issues, contributing as well to the area of adaptive and inclusive fashion.

Keywords: Adaptive Fashion, Garment Personalization, Undergarment, Breast Cancer, Mastectomy

Resumo

As mulheres que foram submetidas a mastectomias enfrentam diversas mudanças e vivenciam uma série de dificuldades, tanto físicas quanto mentais, chegando mesmo a perder o sentimento de feminilidade e a autoestima. Um desafio particular que as mulheres mastectomizadas enfrentam é a falta de opções de roupa íntima adaptadas às suas necessidades específicas, não deixando estas de estar na moda. A opção de roupa interior certa tem a capacidade de ajudar a enfrentar esses sentimentos e influenciar positivamente o estado mental de cada mulher, fazendo-a sentir-se incluída. A moda adaptativa pode oferecer uma maneira de lidar com este problema, tendo potencial para revolucionar a indústria da moda. A presente dissertação visa conceber, desenvolver e avaliar uma prova de conceito de uma aplicação que permite às mulheres mastectomizadas experimentar virtualmente um *soutien* e personalizá-lo, de acordo com as suas necessidades e preferências pessoais. De forma a desenvolver este trabalho, um conjunto de actividades foram executadas. Oito entrevistas foram realizadas, com quatro mulheres que foram submetidas a mastectomias e quatro profissionais de saúde. As quatro mulheres também participaram na actividade de elicitação de fotos. Depois de obter uma visão mais aprofundada do contexto do problema e das necessidades das mulheres que foram submetidas a mastectomias, um modelo 3D de um *soutien* e os protótipos de crescente fidelidade da prova de conceito foram criados. O protótipo final foi avaliado através de testes de usabilidade e de dois questionários individuais, após a sessão, com oito participantes. Os resultados dos testes de usabilidade mostraram que a prova de conceito é fácil de navegar e de utilizar. Isto foi confirmado pelos resultados dos questionários finais de cada sessão, que revelaram uma resposta positiva unânime para com a prova de conceito. Espera-se que o trabalho desenvolvido contribua não só para melhorar a vida das mulheres mastectomizadas, mas também de outras mulheres com problemas semelhantes, contribuindo também para a área de moda adaptativa e inclusiva.

Palavras-chave: Moda adaptativa, Personalização de vestuário, Roupa interior, Cancro da mama, Mastectomia

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1. Introduction

According to the Liga Portuguesa Contra o Cancro (Liga Portuguesa Contra o Cancro, n.d.), the second most common type of cancer amongst women (also in the number of fatalities), after skin cancer, is breast cancer. The last presented numbers show that in 2020, in Portugal, 7 000 new cases of breast cancer were detected, and 1 800 women passed away on account of this disease (Liga Portuguesa Contra o Cancro, n.d.).

The treatments that women who have been diagnosed with breast cancer undergo do not always prevent the need for a surgery, mastectomy, where the breast can be partially or completely removed as a way to treat or prevent breast cancer. After such an invasive surgery woman experience physical and psychological consequences, as the body goes through changes, becoming deformed and impacting the way clothes fit.

One of the garments women use on a daily basis and need to take special attention to on the postoperative stage are undergarments like bras. After a mastectomy, women can no longer wear a bra with a tight fit and underwires. There are crucial aspects that need to be taken into consideration, such as removing underwires, not placing padding in the bra and taking special attention to the used fabric. It would be expected that the fashion industry had the offer of various options for women who have undergone a mastectomy, however, searching the Internet widely for options, this is not the case. This underlines the importance of understanding the needs of women who are battling breast cancer when it comes to garments and dressing. As Sophie Cooper, CEO of the brand I AM DENIM, states[1] "Clothes shopping can be a challenge without a disability but imagine going shopping with the added anxiety of knowing most clothes are not even close to being designed for your needs. No one should feel forgotten or excluded from something as simple as finding fashionable clothes that fit and make them feel good".

Building upon the current knowledge in the field of adaptive fashion and garment personalization, this dissertation aims to study the needs of women who have undergone a mastectomy and had one or both breasts removed (partially or completely) to then design a proof of concept of an app that allows these women to virtually try a bra and allows for the possibility to personalize and adapt the bras to their specific needs and measures.

1.1. Scope and motivation

Fashion and clothing can have both functional and symbolic values. As functional values, the most relevant ones are protection and comfort against natural elements. Symbolic values

[1] https://en.vogue.me/fashion/adaptive-fashion-brands/

include self-esteem, state of mind, group-membership, decoration and respectability (Rosenblad-Wallin, 1985). Not having pieces of clothing adapted to the needs of niche populations, can contribute to even bigger social barriers, with less social participation and self-isolation (Jones et al., 2020).

Although there has been a rising awareness, from the designers, in terms of adaptive fashion and creating garments that are functional for disabled people, the offer, style and aesthetics continue to be very limited. “The fashion industry needs to realize there is a real demand for inclusivity, and affordable, accessible stylish clothing” (Bremner, 2021).

The impact of breast cancer is notorious, since women who have undergone a mastectomy need to embrace a lot of adjustments, emotionally and physically. Besides all the health risks that women face, they also have to deal with affected body image, since breasts can play a very important role when it comes to overall feelings of attractiveness, maternity and femininity (Beard, 2011). Aside from the difficulties mentioned before, women also struggle with the fit and comfort of a garment, in the post-surgery phase. Keeping the problems connected with comfort, fit, style and aesthetics in mind, we can see how difficult it can be to get such an otherwise mundane clothing item.

1.2. Goals and contribution

After mastectomy, women need to take special attention to the type of undergarments they use, since a regular bra can cause discomfort and irritation around the chest area, compromising the recovery; it is also crucial to avoid tight fitted options and underwires (Beard, 2011). After researching about adaptive fashion and solutions for post-mastectomy women, it was understandable that the undergarments options available for this niche of the population are limited and unappealing (Figure 1). Besides this, undergarments are not adjusted to each woman and her needs, which is exacerbated once a woman has undergone mastectomy, contributing to the feeling women have of not being taken into account by the fashion industry. As a result, low self-esteem and self-image are likely to emerge, making women struggle even more, since clothes can have the power to change the way each person feels about themselves (Gao, 2016, p. 10).

Figure 1 - Post mastectomy bra

The main goal, and subsequent contribution of this dissertation, is the design, development and evaluation of a proof of concept of an app, curated especially for women who have undergone mastectomy. The proof of concept of the app should enable women to try out, at home, a bra tailored to their specific needs.

With this approach, the present dissertation intends to gain a deeper knowledge about women's experiences after mastectomy, how they feel and become aware of the undergarment choices in the post-op stage. Likewise, it is of best interest to work side by side with relevant people, such as women who have undergone mastectomy and health care professionals that assist these women, as a way of obtaining this deeper knowledge. Nonetheless, an individual stage of the project was also conducted, ranging from the 3D modulation of a bra model to the user interface design and interactive implementation, with the subsequent validation with end users. By combining the fields of garment personalization and adaptive fashion, through technology, we hope to contribute as a way of celebrating the uniqueness and authenticity of each woman, while keeping comfort and safety in mind.

1.3. Methodology

As stated in the previous section, this work relies on the participation of end users, such as women who have undergone mastectomy and health care professionals that work side by side with these women. So, a participatory design approach was chosen as a way of guiding the development of the work.

Choosing a participatory design approach, such as co-design, is a way to understand and improve the user's experiences by involving key users and stakeholders in all the different design stages (Co - Design Guide, 2018). Co-design also provides a way to discover the blindspots in already existing products, or services (Kuniavsky et al., 2012), providing the designer/researcher, who can perfectly be the same person (Sanders & Stappers, 2008), with information about personal aspirations and values.

In order to follow this methodology, various activities can be planned. To start the process, there is the need to choose and contact key users. After this step, different activities can be followed, such as those that resort to generative activities. According to Mike Kuniavsky (2012), dialogic and generative techniques are very useful in the exploratory research stage, which is the beginning point of the development of this dissertation. Photo elicitation sessions are one example of activity that can be conducted, in order to "open up space for exploration" (Kuniavsky et al., 2012, p. 231). Interviews also take place, working side by side with the previous participants mentioned.

The information collected in the activities will help in the development stage of this work. Prototyping will follow, being divided into evolving fidelity prototypes. To make sure that the prototypes are meeting the participants' expectations, evaluation techniques will take place, being adapted to the different stages the work presents. Evaluation techniques will start with an informal approach, leading to a well thought and prepared one by the evaluator (usability testing). Further in this document, the different approaches and techniques will be well presented and explained.

1.4. Document's structure

This dissertation is divided into seven chapters:

Chapter 1 provides a brief introduction about garment personalization, the motivation and scope, the goals, the contributions of the research and the approach followed. This explanation of the document's structure is also included here.

Chapter 2, State of the Art and Literature Review provides an overview about breast cancer, treatment options, mainly mastectomies, and the implications this disease has both in women and society. Besides these topics, chapter two also highlights the importance of adaptive fashion and garment personalization. As we will see, these three main topics (breast cancer, adaptive fashion and garment personalization) are interconnected. Chapter two also reviews design principles that could guide the design work to finish the chapter, an analysis of existing technological solutions in the field of garment personalization is presented. Current brands regarding garment options for niche populations, for example for women who have undergone mastectomies, also appear in this chapter.

Chapter 3 focuses on the methodological approach that the dissertation follows. Here, user-centered design and participatory design approach are explained, presenting the different stages and activities that are followed. To end the chapter, the work plan is also displayed, through a Gantt chart.

Chapter 4 presents the analysis of the problem and all that is intertwined with it. It is in this chapter that the development of the project starts to take place and be described. In this part of the project, participants start to actively take part in the proposed activities. The storyboards, the conducted interviews, the created personas and the photo elicitation activity are here conferred.

Chapter 5 introduces the 3D modulation that took place, but also the visual identity and style guide created for the present dissertation. In chapter five, the creative process is described and how the 3D modulation was developed, as well as the various steps taken to create the visual identity of the project, such as the logotype, the choices of typography and color, the used layout and grid and the created iconography.

Chapter 6 shows the process of designing the user interface, and the evaluation of the same interface. Here, the various types of prototypes are presented, and the usability tests are carried towards these prototypes. After conducting and interpreting the results, it will be possible to conclude the implications the tests have on the design of the interface.

Chapter 7 presents the conclusions and final remarks of the dissertation, as well as the discussion of the future work.

2. Literature review and state of the art

This chapter reviews the main concepts that support this dissertation. In doing so, it provides a brief overview of breast cancer and the treatments that women go through, in order to better understand the context of the problem. The role of fashion in the psychological state of women is also discussed, addressing important concepts such as adaptive fashion and garment personalization, and how fashion has the power and sway over women's self-esteem, especially after mastectomies. To better understand how to design an effective user interface, a review of design principles was also conducted, with the goal to try to find the design principles that are recognized among the design community.

2.1. Breast cancer, disease and treatments

Although breast cancer is not the most lethal type of cancer, it presents a high mortality rate, especially amongst women. Breast cancer is the second most common type of cancer amidst women, also in the number of fatalities, second only to skin cancer (Liga Portuguesa Contra o Cancro, n.d.). In Portugal, with a female population of five million women, 7 000 new cases

were detected in 2020, and 1 800 women passed away, according to Liga Portuguesa Contra o Cancro (Liga Portuguesa Contra o Cancro, n.d.).

Breast Cancer is a type of cancer that leads to the formation of malignant cells in the tissues of the breast. Multiple factors can contribute to the development of breast cancer, such as family history, inherited gene mutations and other risk factors. Signs of breast cancer can be a lump or a change in the breast, such as redness and swelling. (National Cancer Institute, 2021).

In order to tackle breast cancer, each woman faces "a unique treatment path that may include surgery, chemotherapy, radiation therapy, and treatment with hormones" (Beard, 2011, p. 1). In most cases, it is normal to combine treatments, however, these treatments produce changes in women's bodies, affecting both physically and psychologically. When physical changes are noticeable, women face struggles linked with clothes' fitting, comfort and aesthetic concerns (Beard, 2011, p. 7).

Cancer treatment can be localized or systemic (Liga Portuguesa Contra o Cancro, n.d.):

1. **Local treatment** occurs when the breast cancer cells are removed in the specific area of the breast. In this category, we can place surgery and radiation therapy.
2. **Systemic treatment**, or target treatment, is used in order to control the cancer. The treatments can be chemotherapy, hormonal therapy or directed therapy. It can be used to reduce tumor size before a local therapy so that the procedure won't be so intrusive.

Surgery is the most common treatment for breast cancer (Liga Portuguesa Contra o Cancro, n.d.), and can be divided into breast conserving and non-breast conserving modalities. Conserving surgery includes tumorectomy, segmental mastectomy and partial mastectomy. In these procedures, the cancer cells are removed and not the entire breast. After the surgical procedure, the majority of women go through radiation therapy in order to destroy any cancer cells that might still exist. There are also non-breast conserving treatments, mastectomy, which follow one of the three following procedures (Beard, 2011, p. 3): **simple mastectomy**; **modified radical mastectomy** or **radical mastectomy**. These three procedures are described in section 2.1.1. .

Radiation therapy[2] and chemotherapy[3] can also follow non-breast conserving surgeries, in order to kill any remaining cancer cells, decreasing the risk of the cancer coming back (Liga Portuguesa Contra o Cancro, n.d.).

Post-surgical complications may occur, being the most common one lymphedema. Lymphedema affects the arm and the hand, becoming swollen, and can even lead to nerve pain named post-mastectomy pain syndrome (PMP), which is a sharp pain associated with the

[2] Radiation treatment is a treatment that uses high doses of radiation to kill remaining cancer cells

[3] Chemotherapy is a treatment that resorts to a mixture of drugs to kill remaining cancer cells

nerve affected during the surgery, contributing also to feelings of aching, burning and tightness (Beard, 2011). Lymphedema can be intermittent or permanent, and women need to be careful to protect the swollen area from accidental injuries, like abrasions, burns and bruises, which can boost the edema and cause even more discomfort (Gao, 2016). Besides the discomfort and limited mobility caused by the edema, there is also the added risk of infection, compromising the function of the lymph system (Beard, 2011). The swelling caused by the lymphedema can lead to serious discomfort, loss of functionality and pain (Beard, 2011). The size of the affected arm also fluctuates significantly, which can complicate the fit of the clothing. Due to this it is very important that the clothing does not constrict movements. Other complications after surgery can be scar sensitivity, post radiation skin discomfort and phantom breast pain, interfering with daily activities (Beard, 2011).

After surgery, radiation therapy and chemotherapy can be used as a follow-up treatment. Radiation therapy normally causes general fatigue during, and even after the treatment. The skin becomes red, sensitive and itchy, but these side effects are temporary and will heal, gradually. It is also important to consider the undergarments that are used, such as bras, since they can rub and cause irritation in the skin. It is essential to use soft products and not tight fitted clothes (Liga Portuguesa Contra o Cancro, n.d.). The most common side effect of chemotherapy is hair loss, which affects people in different ways. It can cause only partial hair loss or thinning, or hair loss all over the body, being the most common one the loss of the head hair. In some cases, eyebrows and eyelashes can also fall off. This loss of hair is almost always temporary, and the hair starts to regrow after the treatment is finished. Hair loss greatly interferes with self-esteem and body image (National Health Service UK, 2017). Nausea, appetite loss, menopause, infertility, weight gain and sensitive skin are some other side effects associated with the treatment. “All these difficulties, along with pain and loss of motion, can create emotional anguish, emotional distress, and social barriers" (Gao, 2016, p. 8).

Mastectomy procedure and post-operative options

When a woman undergoes a mastectomy, it means that a non-breast conserving treatment is followed. As stated before, part of the breast, or the totality of it, is removed. Nonetheless, there is always an effort to follow breast conserving surgeries as long as it is possible (Beard, 2011). There are different types of mastectomies:simple, modified radical and radical mastectomy, being the most common ones: the **simple mastectomy** and the **modified radical mastectomy** (Gao, 2016). These three procedures can be described as following;

1. **Simple mastectomy**, where the entirety of the breast is removed, but the lymph nodes beneath the arms, or the muscle tissue under the breast, is preserved.
2. **Modified Radical Mastectomy** removes the entire breast, as well as some of the lymph nodes under the arm.
3. **Radical Mastectomy**, which is currently a rare procedure, but is characterized by an extensive removal of the entire breast, lymph nodes and the chest wall muscles. (Beard, 2011)

As any surgery, mastectomies present physical side effects that are mostly temporary. Pain and sensibility in the operation area are common, through a short period of time, the same with tense and weak muscles (arm and shoulder) (Liga Portuguesa Contra o Cancro, n.d.). Removing a breast, or both, can cause a feeling of unsteadiness, which can lead to discomfort in the neck and back (Liga Portuguesa Contra o Cancro, n.d.). Scaring is also an adjacent problem to a mastectomy, and the skin incisions vary, being "chosen based on the type of tumor, quadrant location of the tumor, facilitation of incision closure, and cosmetic implications. "The remaining body configuration will vary by the type of surgery and the closure technique that was used", as Beard (2011) states.

Following a mastectomy, women can decide to either reconstruct the breast(s), through a reconstructive surgery, or not have reconstruction at all. This decision, linked to the physical side effects of a surgery, will contribute to the psychological impact that breast cancer and mastectomies present to women. The changes that the body goes through after mastectomy are inevitable and women face various challenges when it comes to "self-concept, emotions, behavior, family dynamics" (Koçan & Gürsoy, 2016, p. 145), taking a big toll in each woman's mental health, with each dealing with psychological problems differently. Although women understand the importance and necessity of mastectomy, women thoughts and feelings about mastectomy may shift between being "grateful to still be alive and saw this as more important than the loss of a breast" and experiencing "great sadness at the loss of their breast", (Koçan & Gürsoy, 2016, p. 147).

Post-operation psychosocial impacts

Psychologically, women face various challenges and concerns, being "emotionally afflicted due to the amputation of their breast and surrounding tissues, underarm lymph nodes, and chest muscles" (Gao, 2016, p. 7). Women get concerned about physical-related problems, such as post treatment pain, future health threats and the fear of physical defects. Psychological issues are also a concern, since "any perceived losses may lead to various psychosocial problems" (Koçan & Gürsoy, 2016, p. 146).

These "mental activities and image dissatisfaction", as Gao designates (2016, p. 9), that pre and post-mastectomy patients experience lead to psychological challenges, such as anxiety, depression, negative body image and low quality of life. Women also lose a sense of femininity, attractiveness and power. Self-isolation and feelings of being different arise and haunt each woman in a particular way, forcing them to deal with a new body image reality that can cause psychological problems and feelings of incompleteness (Koçan & Gürsoy, 2016).

Body image can be characterized as " the integration of one's physical and psychological self", and can be "influenced by societal values, culture, and experiences of childhood through adulthood" (Feather et al., 1988, p. 130). In more detail, "body image is defined as

the mental picture of one's body, an attitude about the physical self, appearance, and state of health, wholeness, normal function, and sexuality" (Koçan & Gürsoy, 2016, p. 145). Negative body image is a common psychological concern among breast cancer survivors, who become self-conscious and self-aware about their physical appearance. As Cheng states (2018, p. 2), "mastectomy as a treatment for breast cancer can affect a woman's valuation of her body and sense of self".

According to the literature (Koçan & Gürsoy, 2016), breasts are more than an organ, they are also considered a symbol carrying different meanings. There is a great emphasis and idealization of women, breasts and the female Figure. Ideas of femininity, beauty, motherhood, breastfeeding and attraction arise immediately when thinking about breasts (Koçan & Gürsoy, 2016). Being a symbol of feminine identity, the loss of the breasts can affect women when it comes to self-confidence and feelings of femininity, even more if the woman places a great deal of importance on her breasts for appearance and positive body image (Gao, 2016).

The heavily idealized socially acceptable female Figure, and the consequent emphasis on breasts, can lead to the pressure that women feel in order to conform with these social norms. A stigma is placed around the loss of breast, due to the non conformity with the social norms. Since the female attribute at issue becomes different from the rest of the women, the attribute becomes a stigma, which can be defined "as a unique connection between the attributed and stereotyping" (Miswat, 2021, p. 1).

According to Miswat (2021), there are strategies to overcome stigma. The most common one, when it comes to concealing stigma (
Figure 2), is covering, where the main idea is to cover the flaw. "Covering involves the concealment of a stigma in order to lessen tension, or to remove obvious attention from the stigma" (Miswat, 2021, p. 2).

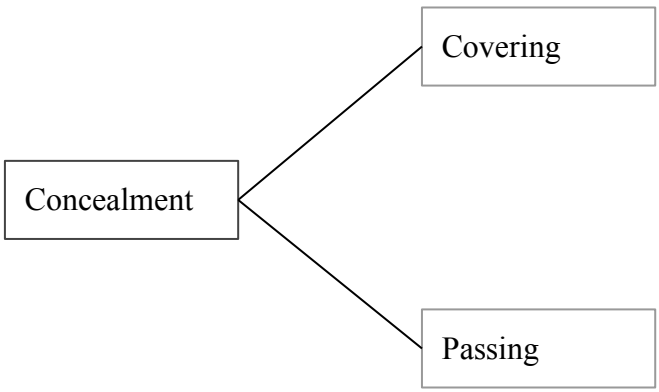


Figure 2 - Concealment strategies (Miswat, 2021, p. 2)

Having introduced the psychosocial implications of mastectomy, the stigma that it is still noticeable towards this subject, and how women end up trying to cover what they consider a

flaw, the next section will present the terms of inclusive and adaptive fashion as a way of helping to overcome the identified problem.

2.2. Inclusive and adaptive fashion

According to Bremner (2021), adaptive fashion came to revolutionize the fashion industry, making it possible for differently-abled people to get dressed in fashionable clothing pieces. The aim of adaptive fashion is to create garments that blend fashion and function, turning the dressing process easier and convenient (Indiano, 2019). This area of fashion recognizes that everybody, no matter the body type and specific needs, has their own sense of style and can use fashion as a way of expressing individuality (Gao et al., 2017).

Fashion and clothing post-mastectomy

Clothing, besides being a necessity in life for protecting the body, can be considered a silent way of communication, expressing different meanings and providing information about the self (Gao et al., 2017). Clothing and fashion are two terms utterly connected, being fashion "clothing that is socially and culturally relevant at a period of time" (Indiano, 2019, p. 18). Fashion and clothing also have the ability to influence the psychological state of the wearer.

Enclothed cognition, a term coined by Adam and Galisnky (2012, p. 919), refers to "the systematic influence of clothes on the wearer's psychological processes and behavioral tendencies". This term, which arose after a study led by the above-mentioned authors, shows the effect that clothing has on a person's mental process and the way they feel, think and function. Enclothed cognition involves two distinguished factors: the symbolic meaning that clothes carry; and the physical experience of wearing each piece, being these responsible for the effects that are seen in the wearer's psychological processes. Following this line of thought, it is proposed that "the experience of wearing clothes triggers associated abstract concepts and their symbolic meanings. In particular (…) wearing clothes causes people to 'embody' the clothing and its symbolic meaning" (Adam & Galinsky, 2012, p. 919). For example, the underwear that each one chooses can sway and increase confidence and self image.

Underwear can be considered as important as outerwear garments, being even perceived, sometimes, as more interesting since they are not visible (Tsaousi & Brewis, 2012). The importance of undergarments concerns the different feelings that can be stimulated and reflected through it, in the most various occasions (Tsaousi & Brewis, 2012). Underwear can carry sensations of femininity, sexuality and the way women perceive and feel their bodies. Overall, is a way of expressing self-identity (Tsaousi & Brewis, 2012).

Undergarments can have different functions, such as working with outerwear to enhance a certain appearance (Tsaousi & Brewis, 2012). The female body is expected to have a certain

body shape, called ‘apple’ or ‘pear’, and undergarments can be used to create an optical illusion in order to achieve this societal accepted body shape. Underwear also contributes to different physical and psychological feelings, for example, being comfortable with each one’s body, self-confidence and even sexual arousal (Tsaousi & Brewis, 2012). This shows how important it is to have a well-fitted bra that supports both outer appearance and the psychological appearance that it is connected with (Tsaousi & Brewis, 2012). Besides, the process of choosing an undergarment is intrinsically connected with fashion and the current trends, the same as with outerwear.

According to Beard (2011), clothes can be used as a way of minimizing the side effects of post mastectomy surgery, both physically and psychologically. Physically, clothing can provide a protective layer against pain and discomfort on the affected areas, offering more comfort to the woman, as long as the appropriate style, fabric and seam style are selected (Beard, 2011). As a way of appearance management, and to diminish psychological side effects, breast cancer survivors turn to clothing as a tool to hide the changes in the body and improve their confidence (Miswat, 2021). Clothing is also used as a way to mimic the traditional female aesthetic and to “camouflage less desirable characteristics and enhance attractive attributes” (Gao, 2016, p. 11).

After a mastectomy, and with the body changes that women face, the clothing options shift and become narrower. Since the clothing selection is limited, women are forced to shift the entirety of their style for the body changes that they are facing, not having the offer of versatile clothing in order to express their true selves, and boost self-esteem (Gao et al., 2017). When designing clothes for post mastectomy women, the garment has to address not only functional attributes, to minimize inhibitions on movement and fit, but also to present an aesthetic functionality to positively promote the altered body shape. It is essential that clothing has the maximum comfort both physically and psychologically (Gao, 2016). However, the lack of clothing options for post mastectomy women, specially accessible clothing that meet the different needs, creates a bigger gap between women and social participation, making the feelings of isolation and lower quality of life more visible (Jones et al., 2020). Women are deprived of truly expressing themselves, through clothing, since the options are limited. Having appropriate garments for women who have undergone mastectomies, that allowed them to feel comfortable and to express their personality, “would positively affect the women’s attitudes and would enhance their self-esteem” (Gao, 2016, p. 12). This is why the proposed work becomes relevant, becoming a way of offering women who have undergone mastectomies appropriate undergarment options, adapted to the needs and notwithstanding the fashion aspect.

The fashion industry and adaptive fashion

Finding clothes that contribute to a higher self-esteem can be difficult for everyone. But it is especially hard for individuals that face various dressing challenges, who do not see their necessities taken into account and are thus not heard by the fashion industry. Here, we can

include people with disabilities, either sensorial, physical or mental, such as women who have undergone mastectomy. When thinking of clothing for these niche populations, it is more recurrent to think of apparel and not fashion. Apparel is simply "defined as clothing whereas fashion is defined as clothing that follows current and social trends" (Indiano, 2019, p. 3). For the fashion industry, and society in general, the clothing used by these niches of the population have been coined as functional clothing. In the early 2000s, the term adaptive wear arose, as a way to replace functional clothing. Adaptive wear "is defined as any item of clothing that can be adapted for a person with any form of disability"(Indiano, 2019, p. 3). For this dissertation, the term Adaptive Fashion will be used, since this is "the term used to describe fashionable clothing for people with disabilities" (Indiano, 2019, p. 4). In the recent years, there has been a rising awareness from the fashion industry for various social concerns, such as: environmental issues; plus size and transgendered models on runways, billboards and commercials. Let us not forget that fashion has the power to reflect the cultural times that society goes through. Nonetheless, adaptive fashion is still lacking in the market (Indiano, 2019). Adaptative fashion items can often be expensive or are not always tailored to the personal needs or style of an individual with special dressing needs (Jones et al., 2020).

Individuals who experience dressing challenges, such as women who have undergone a mastectomy or people with disabilities, do not fit in the "western world's idea of beauty, of tall ethereal men and women" (Indiano, 2019, p. 16), which makes their visibility in the fashion market harder, but "with the aid of social media and Millenials and Gen Z consumers demanding more social responsibility" (Indiano, 2019, p. 16) companies are being forced to change. Besides this, if society is not aware of the difficulties that it is to get dressed with any form of limitation, the issue will not be solved or even considered (Indiano, 2019).

From our research efforts, it is possible to see the rising awareness and effort that fashion brands are conducting in order to create adaptive fashion lines that meet individual's necessities. When designing garments for the wearer, it is important to consider the different needs that clothing addresses (Jones et al., 2020). These can be:

- **Functional needs**, which include safety, ease of movement, handily of dressing and undressing, avoiding friction in sensitive areas, ease of going to the toilet; or
- **Social needs**, where garments have to be suitable for different environments, such as work, social gatherings or formal events.

As the fashion industry realizes the importance of adaptive fashion, so do brands. In 2017, Tommy Hilfiger launched "Tommy Hilfiger Adaptive", a fashion line created for people with disabilities (Bremner, 2021). The clothing line includes easy-open necklines, elastic pull up loops in bottoms (e.g, jeans), extended zipper pull (Figure 3), magnetic buttons (Figure 4), one-handed zippers, sensory friendly garments, sliding drawcords, velcro and wide leg openings for prosthesis wearers. Tommy Hilfiger stated (2021) that the "adaptive collections have revolutionized everyday dressing for people with disabilities, giving them the independence and confidence to express their individuality through style".

Figure 3 - Extended zipper pull option

Figure 4 - Magnetic buttons on jeans

Another renowned brand that invested in adaptive lines is Nike, with the creation of laceless footwear for people with any form of disability or constraint (Bremner, 2021). One of the latest releases was the Nike FlyEase (Figure 5), characterized for being an easy on/off footwear and making the process of putting sneakers on more hands free. Besides the functional aspect, these shoes are also aesthetically pleasing and fashionable.

Figure 5 - Nike FlyEase model

Nonetheless, the fashion industry still has a long way to go, and it starts to truly realize the demand that exists “for inclusivity, and affordable, accessible stylish clothing” (Bremner, 2021).

Garment personalization

The world has been facing tremendous changes in the past years, and that is reflected in various fields, such as fashion. The new dynamics of the global trade market makes it crucial to shift the traditional ways of designing, with new tools and technologies available to answer to the problems faced by society. Some changes that drive these developments in fashion industry can be (Gupta et al., 2006, pp. 1–2):

1. **Globalization**, making it possible for every entity linked to the development and production process (such as designers, manufacturers and buyers) to be located in different parts of the world. The so called phenomenon of global village;
2. **Mass customization**, an “emerging technology solution that can provide personal garment customization that is cheaper and faster”, adding to the need of the fashion industry of designing for the masses;
3. **Rapid and tremendous changes in trends**, where terms like “fast fashion” and “dynamic collections” emerge, making it necessary for brands to deliver new fashion lines every four to six weeks;
4. **The Rise of Social Media**, where it is possible to share everything within minutes, such as clothing lines and fashion trends, which also offers the possibility for consumers to buy clothes anywhere in the world, no matter where the brand is originally from;
5. **The population has changed**, where the traditional 8-10 head and hourglass Figure is not a reality anymore, being this one of the reasons why ready-to-wear does not fit properly to the majority of consumers.

With globalization and the Internet, online shopping has become integral in consumer's daily life, making the shopping experience more convenient, since it can happen at any time and anywhere the consumer desires. But, with online shopping, different problems come up. As mentioned before, designers still create garments for a certain type of body size, not taking into consideration the changes that bodies have suffered over time, making it almost impossible for a piece of clothing to properly fit (Gupta et al., 2006). When purchasing online, consumers guide themselves through a universal sizing chart that is not accurate to the different body shapes that exist, which contributes to the high rates of returning pieces of clothing (Li et al., 2017). This problem made obvious the necessity for creating a solution that would solve the lack of accuracy in sizing charts and reducing measurement errors.

There is an urgent need to provide a more personalized experience when it comes to clothing, since people present different physical characteristics, preferences and needs (Shilkrot et al., 2013). In this context, two concepts emerge: personalization and customization. **Personalization** can be defined as assisting "in customizing features of a product or service to satisfy consumers' needs" (Halepete et al., 2009, p. 144). While "**customization** allows a consumer to choose changes mainly related to color and garment dimensions", in personalization "information is collected to provide services that meet the needs of that particular individual" (Halepete et al., 2009, p. 144). With garment personalization, it is crucial to meet the different needs of the wearer, being these connected with size, adaptive needs or other. Research has explored technological solutions, such as virtual mirrors or virtual fitting rooms, using Virtual Reality, with a view to support the fashion industry to battle this gap that society faces (Shilkrot et al., 2013). With this in mind, this dissertation contributes as a way of fighting the presented gap in the fashion industry, by offering users the possibility to personalize the undergarment given in the proof of concept. Moreover, being also able to retrieve oneself's measurements, users can find the best fit for the undergarment, battling the problem of lacking accuracy in sizing charts.

2.3. Designing solutions for inclusive and adaptive fashion

When designing a digital solution, it is important to take into account design principles that are already established in the design community. The aim of this project is to design and develop a proof of concept of an app, as previously explained. Since mobile applications have become ubiquitous in everyday life, following design principles to guide the creation of those apps is a way to make sure that the created app is produced in the most effective way. This chapter first provides an overview of general design principles, to then focus on design principles for fashion apps.

General Design Principles

When users do not know how to use a certain product/service, such as a technological one, this can lead to frustration and make the user give up. This means that, when interacting with a product, there is the need to Figure out what the product does, how it works and what it is possible to do with it. The user interface provides the way through which the user will interact with the product. As a way of increasing the chances of success when creating a user interface, designers follow design principles.

There are a number of lists of design principles for guiding user interface design. These are the principles by Jakob Nielsen (1994), Ben Shneiderman's (1984) and Donald Norman (2013). Although Nielsen's and Shneiderman's principles played a very important role when it comes to user interface design, we need to keep in mind that these principles were firstly presented in 1994 and 1984, respectively. After analyzing the different authors and what they present, a lot of overlapping of the principles was encountered. For this reason, it was opted to show just one of the authors, Donald Norman, who integrated the majority of the principles presented by previous scholars.

The experience the user has is crucial, since it is something that determines how these users will remember the interactions they had with the designed system (Norman, 2013). If the experience is not enjoyable, making the users not know how to navigate through the system, frustration will arise. As Don Norman stresses, "cognition and emotion are tightly intertwined", making the designer obliged to design with both in mind, as a way of creating the best experience possible. In his book "The design of everyday things", Don Norman presents seven fundamental principles: **affordances**, **signifiers**, **mapping**, **feedback**, **conceptual models, constraints** and, lastly, **discoverability**. These principles are presented and briefly explained next.

Affordances

Affordances can be described as the relationship between a physical object and a person. This relationship focuses on the properties of the object and the ability the user has to determine how to possibly use the object. These two aspects, the properties of the object and its qualities and the ability of the agent towards the interaction, determine the presence of an affordance, as Norman states (2013, p. 11), "affordance is not a property, (...) is a relationship. Whether an affordance exists depends upon the properties of both the object and agent". And, for the success of an affordance, the same needs to be perceived. This notion of affordance was first presented by the psychologist J.J.Gibson. Gibson referred to affordance as "actionable properties between the world and an actor. (...) They are relationships. They exist naturally: they do not have to be visible, known, or desirable" (Norman, 1999, p. 3). The psychologist affirmed that the "world contained the clues and that people simply picked them up through 'direct perception'" (Norman, 2013, p. 12), since he firmly believed that all senses worked together, and the information that each user retrieves from the world is the result of the combination of all the senses. It is important to state that it is possible for an affordance to

exist even if the same is not visible. But, having visibility is strongly appreciated by designers, since it is a way of offering robust clues on how to operate a certain object. This can be known as perceived affordances, which are "visual feedback that advertises the affordances" (Norman, 1999). These perceived affordances help the users to Figure out how to navigate through the various actions, not having the need for instructions.

Signifiers

A signifier is "any mark or sound, any perceivable indicator that communicates appropriate behavior to a person" (Norman, 2013). They can be deliberate and intentional, like the signal of pushing a door, or accidental and unintentional, such as the trails created by previous people walking in the field.

What signifiers help to do is to communicate where the action should take place, since users need to have a way of understanding how to use the object in question. There is a constant search for clues that might help to understand the purpose of the object, how to use it, what is happening and possible alternative solutions. This makes signifiers something that people need and something that designers must provide. No matter the nature of the signifier, "planned or accidental, (they) provide valuable clues as to the nature of the world and of social activities" (Norman, 2013, p. 17). Although affordances and signifiers may have aspects in common, maybe even being mixed up together, in design signifiers play a bigger role since they have the ability of communicating how to use the design. On top of that, signifiers can be represented by a variety of things, such as "words, a graphical illustration, or just a device whose perceived affordances are unambiguous" (Norman, 2013, p. 19). To sum up, signifiers have the need to be perceivable, otherwise they will fail their purpose.

Mapping

Mapping, a term borrowed from mathematics, can be defined as the "relationship between the elements of two sets of things", being an important concept when it comes to design and layout of controls and displays (Norman, 2013, p. 21). Mapping is simply the relationship between controls and their movements or effects, so a relationship between control and display. According to Lidwell (2003) mapping is good, or natural, when the produced effect corresponds to the expectation, for example, when we click on a light switch, we expect for the light to turn on. Good mapping, in the end, is a "function of similarity of layout, behaviour or meaning" (Lidwell et al., 2003). Here, the term of similarity becomes important, since it is something that makes the relationship of mapping predictable and, hence, foreseeable. This design principle tells us that, when placing a control, the same should be done according to the layout and behaviour of the device. To easily use a device, Norman explains that this occurs when a "set of possible actions is visible, when the controls and displays exploit natural mapping" (2013, p. 23).

Feedback

According to Norman, feedback is "some way of letting you know that the system is working on your request (...) communicating the results of an action" (2013, p. 23). There are a few aspects that need to be taken into account. Firstly, feedback must be immediate, otherwise people will easily give up on the action when providing feedback. It must also be

informative, but this must be done carefully, since lights and sound signals used to provide information can easily become more annoying than useful. It is important to have a balance with the given feedback, since too much feedback can also be distracting for the user. Feedback, besides having to be planned as a way of confirming all actions, also needs to be prioritized. The presented feedback works as a signal to the user, but it should be offered in an attention grabbing way. Norman finishes presenting this design principle by stating that "feedback is essential, but it has to be done correctly. Appropriately." (2013, p. 25).

Conceptual Models

A conceptual model is a simple explanation of how something works. This explanation only needs to be useful, with no demand for it to be complete or accurate. The example Donald Norman presents in "The Design of Everyday Things", is a good way of understanding conceptual models and how they work, "The files, folders, and icons you see displayed on a computer screen help people create the conceptual model of documents and folders inside the computer, or of apps" (2013, p. 25). Again, conceptual models can be presented in a very simple way, and that are valuable, although this value only counts "as long as the assumptions that support them hold true" (Norman, 2013, p. 26). Since they are simplified models, these conceptual models can also be known as mental models. As Norman presents, mental models "are the conceptual models in people's minds that represent their understanding of how things work." (2013, p. 26). Mental models can be passed from person to person or even appear in manuals and, normally, the device at stake "offers very little assistance, so the model is constructed by experience" (Norman, 2013, p. 26), showing that there are many ways of apprehending these mental models. Since these models are built upon experience, usually when it comes to devices, the bulk of the clues to understand how things work come from "perceived structure", commonly based on signifiers, affordances, constraints and mappings (Norman, 2013, p. 26). To sum up this design principle, we can conclude that a good conceptual model allows us to anticipate the effects of our actions and, without a good model, users operate in a blind way (Norman, 2013, p. 28).

Constraints

According to Lidwell, a constraint is a "method of limiting the actions that can be performed by a system" (2003, p. 50). When used correctly, constraints can prevent the probability of occurring errors during an interaction. Norman presents four different types of constraints (2013): physical, cultural, semantic and logical.

Physical constraints are constraints that rely on "properties of the physical world" for operating (Norman, 2013, p. 125). The number of possible actions should be limited, to assume appropriate use of the physical constraints. Also, there is no need for special guidance when it comes to these constraints, becoming more advantageous if they are easy to interpret and use, as they prevent wrong actions from occurring right after being tried out (Norman, 2013).

Cultural constraints are intertwined with the social conventions created by each culture. "Each culture has a set of allowable actions for social situations" (Norman, 2013, p. 128).

This set of social conventions is what makes each person know how to navigate and behave in the society in which they are integrated. One of the challenges that may be encountered is the fact that cultural constraints are not "universally accepted conventions"(Norman, 2013, p. 129), which can make it difficult, sometimes, the use of certain machines or systems. Nonetheless, "cultural constraints are likely to change with time", as Donald Norman claims (2013, p. 129).

Semantic constraints are connected with "the meaning of the situation to control the set of possible actions"(Norman, 2013, p. 129). These are constraints that depend on the personal knowledge of a specific situation and of the world, offering clues on how to perform certain actions. Like cultural constraints, semantic constraints can also change with time, since the way each one of us interacts with technologies will also shift throughout the years.

Logical constraints help determine alternatives when navigating a system. Here, there is a "logical relationship between the spatial or functional layout of components and the things that they affect or are affected by" (Norman, 2013, p. 130). Logical constraints are provided by the natural mappings, referred previously. Norman explains these constraints through an example: if there are two light switches controlling the lights, the left switch should control the left light, and the right switch control the right one. If this does not happen, "the natural mapping is destroyed" (Norman, 2013, p. 130) and, subsequently, no logical constraints.

Discoverability

When interacting with a system, or product, there is the necessity to learn how it works, "discovering what it does, how it works, and what operations are possible" (Norman, 2013, p. 10). This is discoverability. It helps us to "determine what actions are possible and the current state of the device", as Norman explains in his publication (2013, p. 72).
Discoverability is a principle that results from the proper appliance of previously presented principles, such as: affordances, signifiers, constraints, mappings and feedback. So, when a design is lacking discoverability, the user needs to make a bigger effort to understand how the system works. Design principles such as signifiers, feedback and constraints, have the ability to increase discoverability and help prevent possible errors (Norman, 2013).

These are the design principles according to Donald Norman, fundamental for designing interfaces in the most efficient way possible, as a way of helping to increase the usability of an interface. Next, the design principles will be analyzed based on existing fashion applications, as a way of figuring out whether the actual fashion applications focus on creating a better experience for the user, based on these principles.

Design principles for fashion applications

After researching design principles and how they should be used in a user interface, it was important to understand how the design principles work with fashion apps. Although a thorough research was conducted, there is not a lot of literature available regarding design

principles in fashion apps. Still, we were able to locate a relevant article (Burghardt, 2017). According to Burghardt (2017, p. 5), there is a common ground when it comes to designate what a fashion app is: "fashion application sells fashion products online". The main goal of these apps is to sell products and gain the customers loyalty, increasing brand image and awareness. The author of "How to design a fashion application with a high customer loyalty" (Burghardt, 2017) states that certain features can influence the customer's loyalty towards the app. These features can be divided into:

- **Mobile features** that represent the technical capabilities of mobile phones. The two features that present a bigger influence into customer loyalty are virtual interactivity and system quality. Virtual interactivity is defined as "the extent to which online users might participate in adjusting the content of a website in real time" (Burghardt, 2017, p. 5). The system quality can be measured through: the style of design, the ease of navigation, response and transaction time, security, clarity of the functionality and the creation of an audiovisual experience.

- **Social features** are associated with the possibility to interact with the content of the app and also other users. These features can either be an interaction with the content or an interaction between users, since they both result in a positive psychological reward for the user. A user can feel rewarded by interacting with the content and personalizing it. Including end users in the product development enhances customer loyalty, since a user is more tempted to use the product they helped to create.

- **Brand mention** gives an indication of how companies market their brands within the application. Brand design has the purpose to create the corporate identity and consists of: typeface, layout, color, stimuli (shape and icons), and presentation style. The purpose of brand content is to deliver and enhance the brand image, referring to imagery, copy, relationship features (communication beyond the website) and sound and video. The features of a brand that influence customer loyalty can be the logo, name, brand design and brand content.

The article also presents two case studies of fashion apps, Zalando[4] and Asos[5], that focus on showing how the design principles are contemplated there. The Zalando case study is particularly relevant, since the principles it follows are, overall, similar to the Norman principles, previously described. Zalando, in terms of virtual interactivity, offers what "seems to be very strong" camera option (Burghardt, 2017, p. 8), allowing the user to take a picture of a clothing piece or pattern and search based on the image. The system quality is analyzed based on the presented design, which is clear, with easily perceived functions, and is simple and accessible to navigate. According to the author, Zalando further offers the possibility to leave comments on products and to change the colors of a certain piece of clothing. The visual style is consistent throughout the entire app. The brand content is considered to be very

[4] https://www.zalando.com/

[5] https://www.asos.com/women/

rich, since every product has, at least, two pictures to illustrate it. The brand design resorts to a font that improves readability, colors that invoke a minimalist feeling to it and, lastly, all the buttons and interactive elements are easily recognizable.

The next section of the document focuses on already existing brands and technological solutions regarding post mastectomy inclusivity and garment personalization, helping to understand what is lacking in the market and how the proposed proof of concept can distinguish itself.

2.4. Current brands and solutions

This section presents brands that create adaptive undergarments for women who have undergone mastectomies and that stand out for making fashionable and beautiful lines. Besides this, it also addresses already existing technological solutions for garment personalization. These solutions include the possibility of garment personalization, body metrics and measurement, 3D technology used and the ability of using the technological solutions at home or in store. For identifying the solutions, a thorough research was held, especially in central locations for downloading and purchasing content (Google Play Store and Apple Store). These solutions were identified and selected because they constitute great garment personalization solutions, making it easy for the user to take advantage of the service at home. Adding up to these reasons, the solutions fall into the work field that it is being proposed to work on, garment personalization and the possibility to virtually try undergarments.

Post mastectomy inclusive brands

Megami

As discussed before, there is adaptive wear and adaptive fashion. When looking at brands that create undergarment options for women who have undergone mastectomies, it is noticeable that the options fall into the adaptive wear category. These options only focus on the functional aspect of the undergarment, and not on the fashionable and aesthetic part. The majority of them resemble sports bras, with plain and basic colors, no textures, not sexy or fashionable.

Megami[6] is a London-based undergarment and swimwear brand that does not fit in the previous description. The aim of the brand is, also, to design undergarments for women who have undergone mastectomies, but they stand out from the other brands due to their values and what the brand stands for. Megami believes in equality for all women, empowering them and enhancing their confidence through quality and fashionable undergarments options, being

[6] https://megami.uk/homepage

aware that lingerie plays an important role in making women feel feminine and confident, while also being comfortable and fitting properly. It creates elegant options, wire-free, with full-coverage and breathability, making women feel comfortable, strong and feminine.

The brand started after the founders noticed how hard it was for post-mastectomy women to shop and also to find fashionable lingerie. This was a reality for women around the world, where women needed to give up shopping because they could not find beautiful options, making it visible the huge gap existing in the lingerie market. Megami is brand concerned with providing beautiful undergarments for women who have undergone mastectomies (Figure 6), since they are aware that fashion plays a strong role in the psychological state of each woman. Their undergarment options have the ability to make each woman feel sexy and heard in the fashion industry.

Figure 6 - Megami's Allure Bra

Oysho

Recently, the spanish clothing retailer Oysho, released a lingerie line for women who have undergone mastectomies, presenting four different models of bras. These bra options are designed for women who have undergone mastectomy, do not use prosthesis and opted for not having breast reconstructive surgery.

All the offered options present the same characteristics based on the specific needs of women who have undergone mastectomy:

- Unicup, if necessary;
- Front and back zip, with various positions;
- Without underwire;
- Adjustable straps;
- Breathable material.

Besides taking into consideration the specific needs of women who have undergone mastectomy, the options offered by Oysho are also affordable ones.

Although some models presented are trivial, and that women are used to seeing, there are a few options that stand out for being elegant options (Figure 7). On the one hand this shows that the brand is concerned with both the functional and aesthetic aspect that the

undergarment needs to have. On the other hand, it further exposes a growing awareness of fashion brands to the problem presented in this dissertation.

Figure 7 - Lola multiway bra

Garment personalization apps

In order to design the proof of concept this dissertation proposes and understand the current context, it is necessary to research and evaluate different technological solutions in the field of garment personalization. In performing a critical analysis of existent solutions, we sought to identify garment personalization functionalities, such as: body metrics collected; avatar created (general 3D model or photorealistic); context of use (in-store or at home); and other relevant aspects, for example SDKs (Software Development Kits) and the possibility to save images. After conducting research on the web, especially in websites that allow downloading and purchasing content (Google Play Store and Apple Store), and the resulting analysis of the various solutions, four garment personalization apps that allow the user to try different garments and find the perfect fit emerged as particularly interesting.

in3d

In3d[7] is a solution that allows the user to create photorealistic avatars for different uses, such as fashion, gaming and entertainment, offering an SDK that can be used across various platforms. The scanning process, in order to obtain the 3D avatar, is achieved through a 360º video of the user. To create the most photorealistic 3D avatar possible, it is necessary to do a head and body scan, except if the avatar is only used for body measurements, where in this case the head scan is optional. After this, a full digital replica of the user is created based on 100 frames extracted from the video.

[7] https://in3d.io/

To get the best quality possible in the creation of the 3D model, there are a few factors to take into account:

1. **Optimal light conditions**, where the video is being taken;
2. Try to have **as little interference as possible**;
3. Do **not have objects** between the user and the camera;
4. Use **tight fitted clothes**, especially if the goal of the scan is to be used for body metrics or a virtual fitting room.

The **3D avatar** that is created (Figure 8) is supported across various formats, and can be exported in any 3D format, such as FBX, DAE, USDZ, OBJ and GLTF. The models, if used for gaming purposes for example, can be rigged and pre-rigged in order to be compatible with Mixamo animations. In terms of **body metrics**, the average accuracy that can be achieved is of 1 cm across all points of the body. The 3D model offers over 200 body measurements, besides the possibility of customizing the values and obtaining an endless combination of measurements.

The **virtual fitting room** functionality, also offered by this solution, is a way of trying clothes in the 3D avatar, using the mobile app TRAI. This allows the user to try different items within minutes, see the exact fit and choose the right size. The virtual fitting room supports 3D models of garments that the user can upload and see how they fit. It also supports 2D patterns of clothing, being converted after in a 3D model in order to be used in the virtual fitting room. Besides these options, the user can also upload photos that are later transformed in 3D models.

The solution presented by in3d becomes relevant due to the technological approach used. The main positive functionalities of in3d, is the realistic 3D avatars that are created based on the user, with a high average accuracy of measurements. Besides this, the app can be used at home, which is of great value since online shopping is increasing among consumers. Online shopping, as stated previously, is more convenient for consumers (Gupta et al., 2006, p. 2) and that is why it is more and more used. However, this type of solution also creates problems, such as the high number of returns made since the clothes do not fit properly, and consumers do not have the chance to try them before purchasing (Gupta et al., 2006, p. 2).

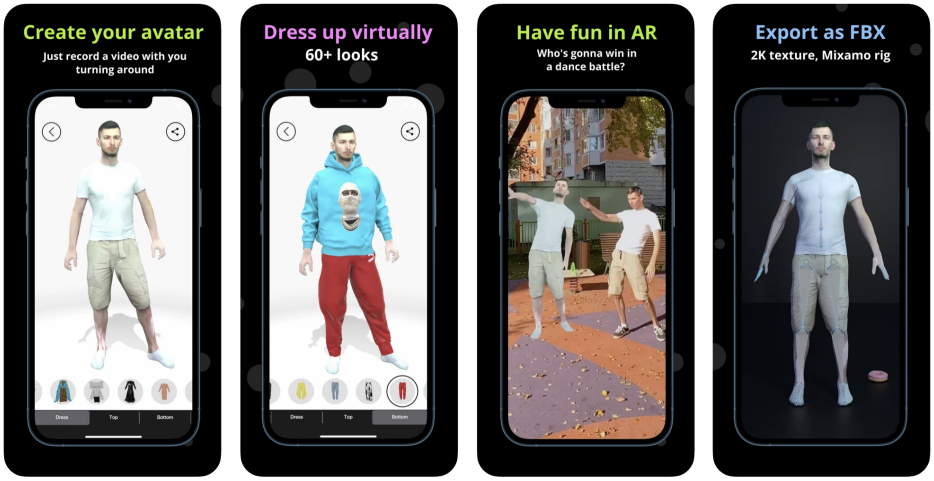


Figure 8 - in3d app layouts

Unspun

Unspun[8] is a brand that takes advantage of a technological solution to offer fitted jeans, based on garment personalization. The users have the possibility to create the best jeans, choosing the specific style, the fabric, stitch, color, waist, rise and length (Figure 9). In order to virtually try the fitted jeans, a 3D avatar is created based on the user. To develop this digital avatar, the user needs to record a 360º video on the app to scan the entirety of the body. It is advised to wear for-fitted clothing and be in a well lighted room.

Unspun offers the possibility to virtually try and choose the best fitted jeans from the brand. This gives the possibility to personalize the garment, making unspun an inclusive brand, with sizing options for everyone. Besides this, unspun is also a sustainable brand.

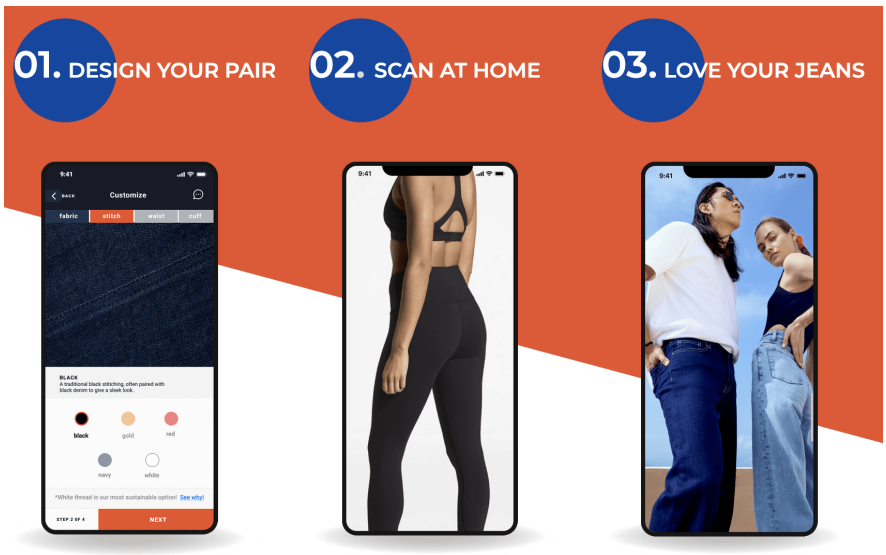


Figure 9 - Process for personalizing and trying jeans with unspun

[8] https://unspun.io/

PICTOFiT

PICTOFit[9] is a platform that allows users to virtually try-on various garments, in a virtual fitting room, using photorealistic avatars created by the users. The fitting rooms that are provided during the experience are virtual and interactive, making it possible for the user to engage with the experience, products and brands.

In the **virtual fitting room**, it is possible to experience a photo-realistic Augmented Reality wardrobe of the user's products. The user can even create a photo realistic avatar for a fully personalized experience and get accurate size recommendations (Figure 10).

Besides the virtual fitting room, PICTOFiT also offers the functionality of **scalable fashion image generation**, where the customer can transform simple garment shots into lifelike on-model imagens, being this possible through the feature of 3D product capturing and viewing.

The platform provides an easy to integrate SDK that can be easily used on a mobile device (iOS/Android). This is an effective way to connect in-store and online experiences, making it possible for the user to be at home trying garments and being comfortable doing it.

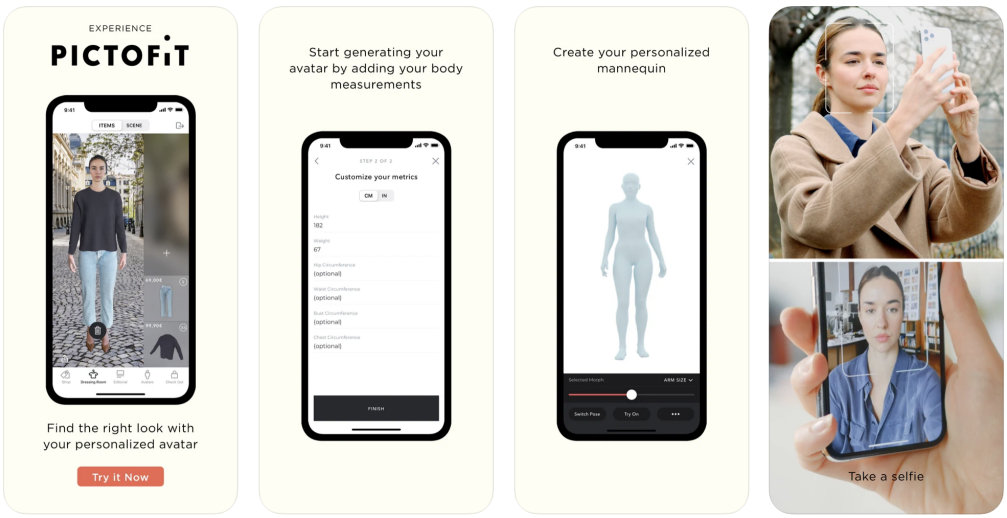


Figure 10 - PICTOFiT app layouts

ViuboxMirror

ViuboxMirror[10] is a solution that makes it possible for the user to virtually try-on clothes, on a virtual mirror placed in-store. This solution offers interesting features, such as:

1. **Precise Body Mapping,** making it possible to virtually try-on clothes in real time and offering the best fit possible, personalized for each user (Figure 11);
2. **Realistic 3D models**, of garments and accessories (Figure 12);

[9] https://www.reactivereality.com/

[10] https://viubox.com/products/virtual-dressing-mirror/

3. **3D models rendering service**, with the use of a 3D conversion tool that helps to convert photos to 3D designs and models;
4. **Live Fitting**, where the users can see themselves virtually wearing the clothes, in real time;
5. **Minimal calibration;**
6. **Face Recognition;**
7. **Background Removal**;
8. Possibility of **saving images**, either through a QR Code or email.

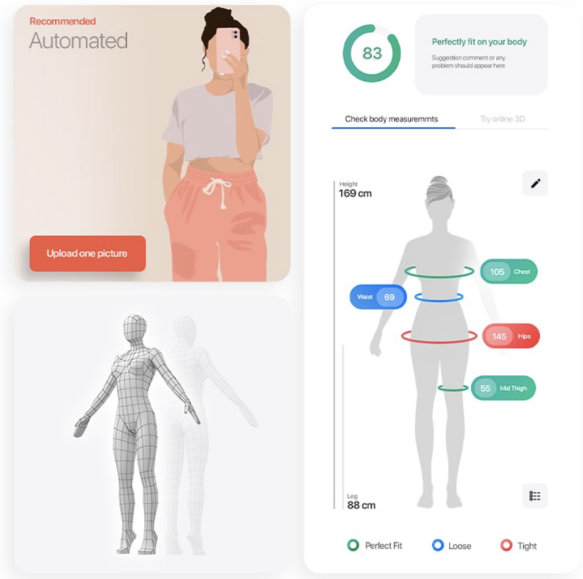


Figure 11 - Body Measurements with ViuboxMirror

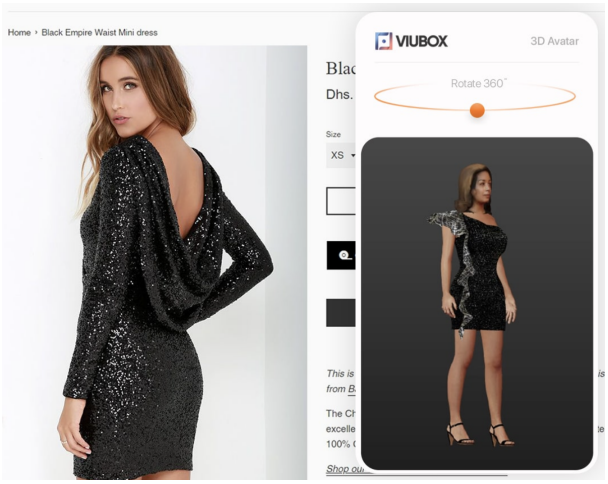


Figure 12 - 3D model created with ViuboxMirror

ViuboxMirror is presented as a relevant solution due to the virtual mirror functionality. Although solutions that can be used at home are privileged, ViuboxMirror is a good option

when it comes to virtually trying clothes on a 3D Model, offering, as well, precise body measures.

Table 1 provides an overview of the four technological solutions previously presented. The table is divided into functionalities and context of use, since these two are the main points for the evaluation of each solution presented.

	in3d	**unspun**	**PICTOFiT**	**ViuboxMirror**
Garment personalization option		- Custom fit jeans - Jeans pattern created by the software - Inclusive brand (sizing options for everyone)		
Body metrics	- Average accuracy of 1cm for measurements		- Accurate size recommendation	- Precise body mapping
Created avatar	-Photorealistic 3D avatars (for fashion, gaming, entertainment) - Rigged and Pre-Rigged models	- 3D avatar based on the user	- Photo realistic avatars	- Realistic 3D models
Other relevant aspects	- Virtual Fitting Room through the mobile app (TRAI); - Website integration (fully customizable virtual fitting room; integrated on a product page) - Available SDK for 3D models	- Sustainable awareness	- Virtual and interactive fitting room; - 3D product capturing and viewing - Easily integratable SDK; - Connection between in-store and online experiences;	- 3D models rendering (convert photos to 3D designs) - Multiple clothes can be tried on at the same time - Live fitting - Minimal calibration - Face Recognition - Background removal - Save images (QR Code or email)
Context of use	Home	Home	Home	In-store

Table 1 - overview of technological solutions

The analysis of these solutions helped to understand what already exists in the market and if there are any valuable features that are capable of being incorporated in the proposed work. All the previously presented digital solutions became relevant since they all offer the possibility, to the user, to create a 3D avatar. With the 3D avatar, users could virtually try pieces of garment. The focus was to find digital solutions that are intended to be used at home, although ViuboxMirror was created to be used in-store. Still, ViuboxMirror digital solution is relevant to the project for the precise body mapping, 3D avatars and the 3D models rendering that it offers. From the presented digital solutions, there is one downside that is common to almost every single application. Only one of the solutions, unspun, offers the possibility to personalize the garments, which is something that this project proposes to do.

After comparing the solutions (Table 1) it was possible to conclude that the solution in3d is the one that is prone to be integrated in the proposed work. The SDK (Software Development Kit) that this solution offers is of added value, being possible to incorporate across various platforms such as Unity, the platform chosen to develop the work. The solution developed in this dissertation takes inspiration from the different apps previously presented, and summarized in Table 1. It uses functionalities such as realistic 3D avatars, present in all four analyzed apps, but it also has a virtual fitting room where the user can interact. Nonetheless, there are a few characteristics that are not present in the others, such as the possibility the users have to retrieve their personal measures, adapt the measures for best fitting possible and, to finalize, the possibility to customize the chosen bra.

2.5. Chapter summary

Having a deep understanding of the main topics concerning the dissertation topic is crucial, in order to develop the project proposed. The first topic that is introduced is Breast Cancer, giving an overview of the disease and possible treatments, with special focus on mastectomies. After this overview of Breast Cancer, it is possible to understand some major physical and psychological effects that surgery produces on women.

With the literature review, it is possible to conclude that fashion works as a way of boosting self confidence and helps to deal with stigma created around the loss of a breast, that is not only an organ but also a symbol of femininity for each woman, and for society in general. Niches of the population are often forgotten by the fashion industry, and are left with few options of clothing that are suitable for their dressing challenges and, most of the time, the garments are not beautiful or even considered fashionable. This takes a big toll on each one's self-esteem and body image. The industry has been evolving over the last decades, taking into account the various needs of the individuals. Here is where Adaptive Fashion enters, revolutionizing the fashion world.

Adaptive Fashion designs garments to help people to get dressed, feel empowered and fashionable, all at the same time. Simultaneously, garment personalization is another field

that offers advantages for niches of the population that present difficulties when it comes to getting dressed or even the simple task of having clothes that fit the body and the specific needs of each one. Technological solutions have been developed, turning the process of virtually trying clothes easier.

This chapter also presented Norman's design principles and that are intended to be used as a guide for the later design stage, namely in the evolving fidelity prototypes created. These design principles are a great way to ensure that the user interface layouts are well thought for the end user, communicating the desired end goal. This chapter also analyzed fashion applications and how they implemented design principles to gain users' loyalty, a crucial point when having a fashion app.

The analysis of existing technological solutions clarified how each solution can enrich the garment personalization experience. Across the presented solutions, the ability of creating a 3D avatar based on the user is a reality. With this functionality, users are allowed to virtually try on garments and, in some cases, even personalize these garments. Although some of the presented systems allow users to create 3D models of personal clothing pieces, such as the case of PICTOFiT, none of the solutions offers adaptive fashion options. This is the gap found during the research, and that is intended to be tackled in this work.

3. Methodology and work plan

This chapter presents the methodology chosen to guide this work and the research stages of the project. First, this chapter provides an overview of user-centered design and participatory design, two approaches that served as a base for the design and development stage. Figure 13 provides an overview of the methodology approach, presenting three main stages of work: user research, conceptualization and prototyping, and evaluation. At the end of this chapter, a detailed work plan is also presented.

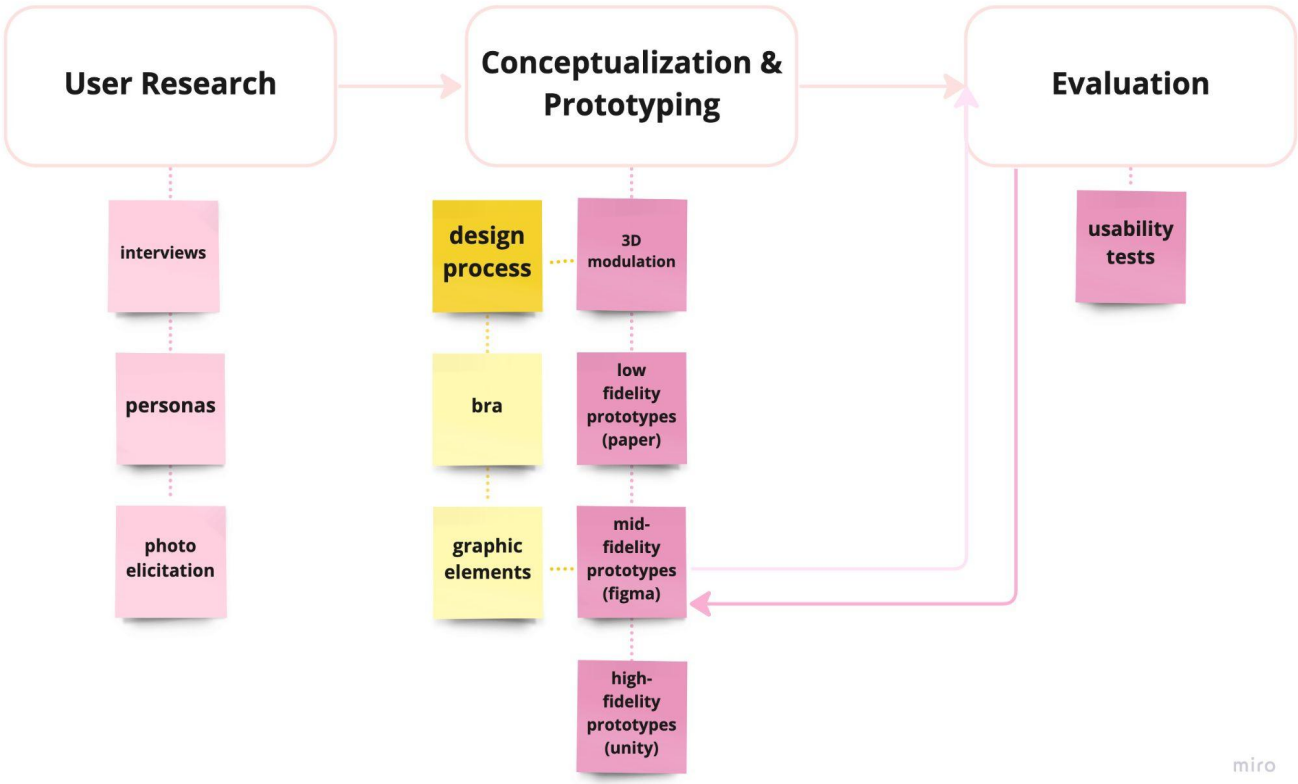


Figure 13 - Diagram of the methodology

3.1. User-centered design and participatory design

When a designer is challenged to develop a product or a service, the designer should place the user in the center of the design and development process, no matter in which phase of the process it is. We are not only designing for users, but also for their future experiences, since people are becoming more informed in the most various fields (Sanders & Stappers, 2008). There is a greater need to pay attention to people's experiences, emotions and needs (Sanders & Stappers, 2008). According to Kuniavsky, user-centered design is a process that "often demands that developers shift perspectives and spend time walking in their users' shoes" (Kuniavsky et al., 2012, p. 676). While user-centered design focuses on the product or service that is being designed, searching for ways to meet the users' needs through the application of various methodologies, participatory design is more than this. It is considered a way of thinking and an attitude towards the user, being characterized as "the belief that all people have something to offer to the design process and that they can be both articulate and creative when given appropriate tools with which to express themselves" (Sanders, 2002, p. 2).

In participatory approaches, the roles of the researcher and the designer begin to merge, making the user "a critical component of the process" (Sanders, 2002, p. 3). It is relevant to study the user and its background to understand how they think, how they feel and how they act, since people have a difficulty to express, verbally, feelings and knowledge towards the world (Kuniavsky et al., 2012). Having access to people's experiences, designers can put the user at the center of the design process, being aware of these experiences and the special needs, desires and dreams each user has. According to Sanders (Sanders, 2002), the possible ways to attain the particular experiences of each user, can be obtained through:

1. **Listen** to what people say;
2. **Interpret** what people express and make inferences about what they think;
3. **Watch** what people do;
4. **Observe** what people use;
5. **Uncover** what people know;
6. Reach toward **understanding** what people feel;
7. **Appreciate** what people dream.

This produces a deep level of empathy with the user, establishing resonance between the designer and the user. Becoming aware of the user's feelings and dreams, turns the "user experience the source of inspiration and ideation for design" (Sanders, 2002, p. 3).

According to Kuniavsky (2012), co-design can be divided into three main types of techniques:

1. **Dialogic techniques**, for stimulating discussion with participants;
2. **Generative techniques**, where participants are able to externalize emotions and thoughts through the creation of objects;
3. **Associative techniques** that help to uncover how participants organize information regarding a subject.

Dialogic and generative techniques are a great way to find blindspots, in an already existing product or service, but that is intended to be updated (Kuniavsky et al., 2012). They provide the designer/researcher, who can perfectly be the same person (Sanders & Stappers, 2008), with information about personal aspirations and values.

Make tools are a design tool, built upon experience, that are intended to be used either by users or designers. These tools "facilitate exchange between the people who experience products, interfaces, systems and spaces and the people who design for experience" (Sanders, 2002, p. 5). Different types of toolkits can be presented, such as emotional toolkits or cognitive toolkits. Emotional toolkits allow the user to show and tell personal stories and dreams, otherwise not shared, and can be materialized through collages, diaries and photo elicitation. Cognitive toolkits, on another hand, allows participants to showcase diagrams of relationships, flowcharts of processes and cognitive models (Sanders, 2002). Toolkits have the power to offer access to the emotional side of the experience, and acknowledge the

personal perspectives of each participant, revealing personal histories that can contribute greatly in the design process. Besides this, the participant also has the ability to become involved in the creative process of designing the product or service (Sanders, 2000).

Taking into account the previous exposure of methodologic approaches, the methodology followed in this dissertation resorts to a combination of user-centered and participatory design approaches. Being the purpose of the development of this project to understand how women feel, learn about their experiences and what they know about breast cancer and undergarment choice in the post-op stage, dialogic and generative techniques are followed. In the next topic, these techniques and the toolkits used to produce user generated-artifacts are explained.

3.2. User research

As stated previously, a participatory design approach was followed. This section presents a clear focus on comprehending the user needs and motivations. Here, one can find the conducted activities and the steps each one has.

Ethical approval

To work side by side with the participants raises questions regarding the privacy of the participants and data protection, all of this linked with ethical questions. The information to be collected can be very personal, since it regards such a delicate subject. Keeping this in mind, the form of informed consent from the Faculdade de Psicologia e Ciências da Educação da Universidade de Coimbra was filled and submitted for approval (Annex 1). This form presents a brief explanation of the project, sustained with the scientific justification of the investigation. With this document, the Comissão de Ética was able to understand the conducted investigation, the participants to be recruited, the risks and benefits of the investigation and how the data was protected. In the same document, the informed consent form can be found. Data protection and confidentiality rights are also presented, being the participants aware of the rights and the withdrawal of participation. The privacy of participants and the respective data protection is ensured and respected. This study also makes sure not to jeopardize the participants in any way.

Recruitment

In order to follow the proposed methodology, it is crucial to recruit participants. The participants are chosen based on their personal experiences regarding breast cancer and mastectomy. They can be divided into two groups: **women who have undergone mastectomy**; and **health care professionals**. The health care professionals recruited are doctors and psychologists that work side by side with women who have undergone

mastectomy. Doctors have the ability to offer scientific input to the project, sharing knowledge about mastectomies, the impact it has on women and the precautions women need to have after a mastectomy, especially when it comes to choosing a bra. Psychologists will help to understand the psychosocial impact a mastectomy can produce on women. Besides, psychologists can provide scientific insight about the role of fashion and clothing in the psychological state of women who have undergone a mastectomy.

For recruiting, two distinguished paths were followed, establishing contact through email or phone:

1. **Personal contacts**;
2. **Organizations**, such as Liga Portuguesa contra o Cancro.

At the end of the recruitment process, the goal was to recruit ten participants: five to seven women, one to two doctors and one to two psychologists. A range that would provide a good spectrum of people and different experiences. With the process completed, it was possible to move to the next stages of the participatory design approach, which were the interviews.

Interviews

Interviews, in the field of user research, is something formal and standardized that tries to be nondirected as a way of minimizing "the perspective of the person asking the questions" (Kuniavsky et al., 2012, p. 169), allowing to deeply explore participants' thoughts and experiences (Kuniavsky et al., 2012). User research interviews fall into a predefined structure, composed by six stages (Kuniavsky et al., 2012, pp. 170–171):

1. **Introduction**, from the participants and interviewer. This will allow to set a more comfortable environment for answering questions and sharing personal and somewhat deep experiences;
2. **Warm-up**, as a way for participants to start to focus on the work presented and answering questions;
3. **General issues**, with an initial round of general questions;
4. **Deep focus**, where the idea, product or service is introduced and participants concentrate on details, experience and the ability of using the service or product;
5. **Retrospective**, where users evaluate and talk about the idea in a broader light;
6. **Wrap-up**, as a way of formally completing the interview.

Personas

With the goals and behavior patterns observed during the interviews, it was possible to create personas. Personas are "not a real person, but a synthesis of facts and observations about the users" (Kuniavsky et al., 2012, p. 587). It is a way of representing people, and it is best used in these early stages, before starting developing the work.

When creating a persona, it is valuable to analyze what the interviewed participants have in common, becoming possible to understand shared aspirations towards the presented work. Besides, it is also important to see the points of disagreement. This allowed us to find patterns in the user behavior, and patterns tend to drive user goals and needs (Kuniavsky et al., 2012). Personas are a great way of gaining familiarity and empathy with users. Understanding the needs and desires of the users is a way of achieving good design (Kuniavsky et al., 2012)

Photo elicitation

When it comes to participatory design activities, the first set of activities relies on dialogic techniques, in order to stimulate discussion with participants. One popular technique used during this stage, according to Kuniavsky (2012, p. 232), is photo elicitation, where pictures are used "to stimulate vivid, concrete, meaningful words" in order for participants to respond to a set of questions linked to pictures shown by researchers (Kuniavsky et al., 2012). The aim of this activity is to understand personal interpretations that each participant has towards each question/picture, while recalling previous experiences that are relevant to the development stage.

3.3. Conceptualization and Prototyping

After conducting a user research, when a deeper understanding of the final user was gained, relevant information was collected and considered for the conceptualization and prototyping stage. Nonetheless, some phases were achieved based on the academic knowledge gained throughout the years and extracted from the literature review. The following section presents the various stages this conceptualization and prototyping contains.

Visual identity

When developing a proof of concept of an app, defining the visual identity is crucial, as a way of visual representation. For creating the visual identity, the developed graphic elements were supported by the fundamental principles of design, introduced by Donald Norman. Resorting to these principles of design helped to ensure that the design was created in the best way possible, being functional and appealing to the users. Besides the design principles presented by Norman, it was also resorted to the work of Alan Cooper and his book "About Face" (2014) and the system created by Google, Material Design[11].

Although working with end users is crucial in this project, this phase of the project was created independently, without input from the participants of the participatory design

[11] https://m2.material.io/

activities, but keeping the insights gained in the previous phases in mind at all times. Having a coherent visual identity is very important, for correctly communicating with end users of the service, but also providing the best experience possible. It is the first impact the users have towards the proof of concept, turning the service into something memorable to the eye of the end users. The created visual identity plays an important role in the prototype phase, especially in the medium-fidelity stage. It is in the prototype phase that the created graphic elements are employed, so it is fundamental that they are created previously. Regarding the visual identity of this project, one can find: Logotype; Typography; color scheme; Layout and grid; and iconography.

3D modeling

This stage combines both conceptualization and prototyping, for creating a model of a bra designed for women who have undergone mastectomies. Firstly, there is the conceptualization stage, where it is understood the needs and desires women have towards bras for the post-op stage. To achieve this, information from the participatory design activities is retrieved, regarding the needs towards post mastectomy bras. After organizing the information, it is possible to move to the prototype stage of the 3D modulation. The prototype stage consists, firstly, of designing bra options that contain the aspects required by the participants. After the paper sketches are done, it is possible to start the 3D modulation, resorting to the software Blender[12]. This allows to create a 3D model of a bra, to later use in the high-fidelity prototypes of the proof of concept.

Prototyping

Prototyping is an important step for designing the proof of concept in order to transform the information previously obtained into visual representations, allowing the participants to interact with these representations. Prototyping can present distinct shapes, ranging from "paper-based outline of a screen" to a "complex piece of software" (Preece et al., 2002, p. 241). The limited representation of the final product or service that the prototype represents, allows the users to interact and explore the various functionalities planned, and see if it meets their particular expectations. Evolving fidelity prototypes were created. The first round of prototyping consists of low-fidelity prototypes, i.e. paper prototypes. This is a quick way to visually represent ideas and present them to the user, and confirm whether the proposed design meets user desires and expectations. For the medium and high-fidelity prototypes, a digital approach was used. Figma, Unity, and the associated programming language C#, was the chosen platform to create the proof of concept of the intended dissertation. Adding to these technologies, the Intel RealSense Depth Camera[13] was tested, as a way of understanding if it was possible for participants to virtually try undergarments at home. As presented in the topic regarding garment personalization apps, in3d offers an easy

[12] https://www.blender.org/

[13] https://www.intelrealsense.com/depth-camera-d455/

integratable SDK (Software Development Kit)[14] for 3D avatar models. The SDK gives access to in3D avatar models, with textures and rigged, being compatible with Unity. This SDK was also explored in the prototyping phase.

3.4. Evaluation

In order to understand if the product or service is "usable by the intended user population" (Preece et al., 2002, p. 230), evaluating becomes relevant. During an evaluation phase, users are asked to complete previously defined tasks regarding the system being evaluated (Preece et al., 2002). In a more advanced stage of prototyping, when more functionalities are defined, usability testing is the chosen technique for user experience evaluation. According to Kuniavsky, "usability testing examines how people perform specific tasks, guiding the definition and implementation of functionality" (Kuniavsky et al., 2012, p. 345). In this evaluation technique, participants are asked to carry out a set of carefully prepared tasks, where the performance is measured in terms of errors and time taken to complete the tasks. While users are performing the task, they are being watched and recorded. This helps the designer to better recognize errors, time taken to complete a task and to understand why the participants had a certain behavior towards the tasks (Preece et al., 2002). The gathered data is mainly quantitative, obtained through questionnaires or interviews made to the participants. The approach is based on experimentation and produces outputs that provide a benchmark for improvements of the idea, based on performance measures and errors (Preece et al., 2002).

3.5. Work plan

As a way of structuring the work developed, a work plan was elaborated. This plan consisted of estimating and planning the tasks, methods and the amount of time needed for each stage. In September 2021, a first work plan (Annex 2) was created for both semesters. But, after conducting the work in the first semester, and having a milestone in the beginning of February, revisions were necessary.

Figure 14 and Figure 15 presents the revised Gantt chart, planned after the first milestone of the dissertation. In this Gantt chart, it is possible to see how the work took place in the first semester and contemplate a more realistic plan for the second semester. Nonetheless, this work planned had to be revised again (Figure 16) for the last three stages of the dissertation development: prototyping and implementation, evaluation and dissertation writing.

[14] https://assetstore.unity.com/packages/3d/characters/in3d-avatar-sdk-205111#description

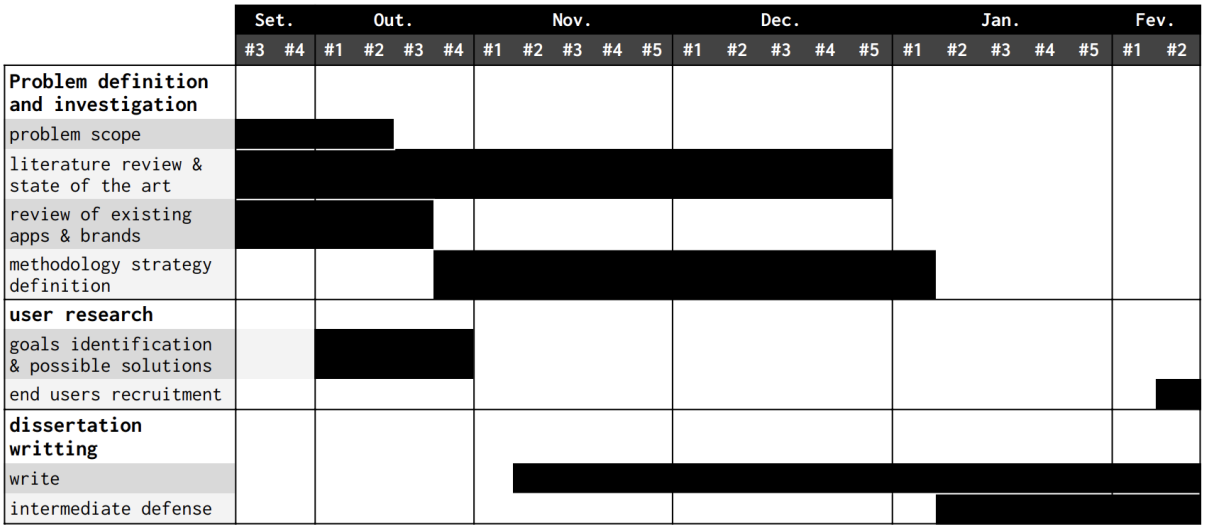


Figure 14 - Revised Gantt chart - first semester

Figure 15 - Revised Gantt chart - second semester

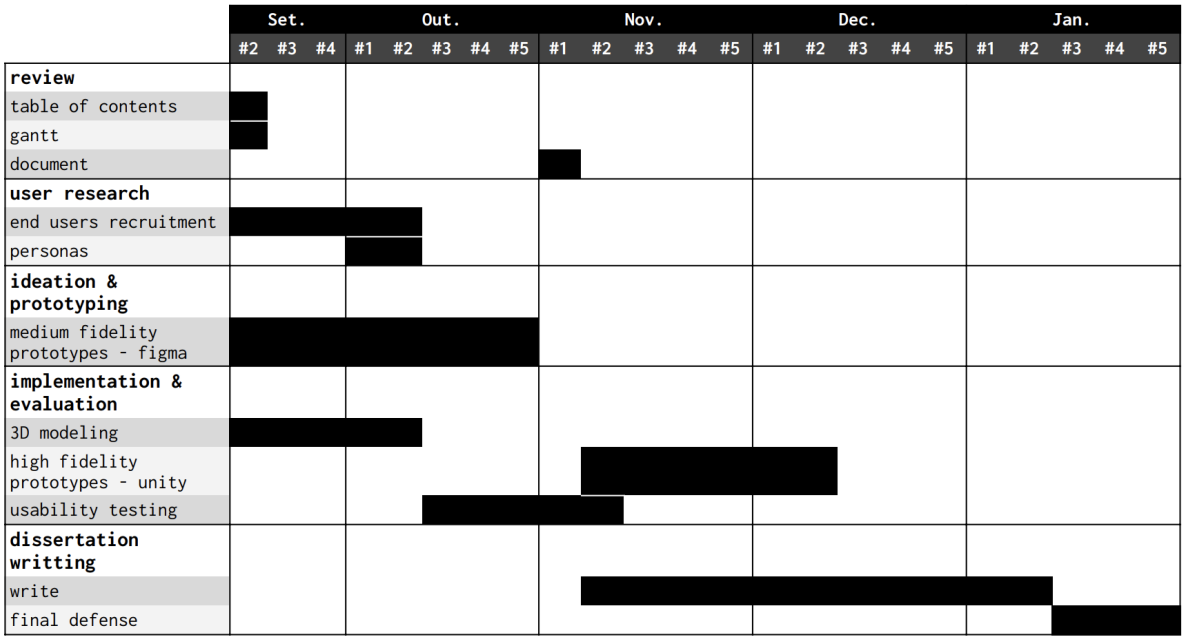


Figure 16 - Final Gantt chart

This new work plan (Figure 16) starts in September and contemplates the whole work process until the deadline of the dissertation in January. For better organization, the new Gantt chart is divided by weeks and each week has an assigned task. Starting in September, it was necessary to revise the previous work plan and organize it again, according to the new time frame. At the same time, it was time to start to develop the medium-fidelity prototypes, starting in mid-September and going until the end of October. In the week after starting the medium-fidelity prototypes, the 3D modulation of a bra option took place. After revising the work done previously, it was noticeable that having a chapter dedicated to design principles was lacking, so it is also planned to do some literature review regarding this topic. Before starting to prepare the usability tests, it is fundamental to have a recruitment phase, since the availability of people can be hard to obtain. Keeping this in mind, the recruitment phase took place two weeks prior to the usability tests, starting from the 31st of October until the 11th of November. After conducting the usability tests of the medium-fidelity prototypes, adjustments were made and proceeded to develop the high-fidelity prototypes in Unity. These prototypes were developed from the mid of November until the second week of December. In the last week designated to develop the high-fidelity prototypes, it was planned to start preparing the usability tests for the high-fidelity prototypes. But since the medium-fidelity prototypes proved to be successful in the usability tests, we concluded a new round of tests was unnecessary. Chapter 6 offers a detailed view of the tests and the analysis of them, explaining why the medium-fidelity prototypes were a success. The document of the dissertation will be written from the beginning of November until the second week of January, with revisions and corrections in between. The work plan ends in the third week of January, with the delivery of the thesis and the preparation for the defense.

3.6. Chapter summary

This chapter presented the different research stages that the work is intended to pursue. While user-centered design focuses on developing a product or service that will eventually meet the users' needs, participatory design works side by side with the participants as a way of truly understanding their desires and needs. Co-design includes various techniques that allows designers and participants to work together. Combining elements from these two approaches, it was possible to gain a better sense of the experiences of women who have undergone mastectomies. From the realm of participatory and co-design, dialogic techniques and generative techniques were chosen to lead the work sessions. These techniques are used to get in-depth knowledge of the participants, their aspirations and needs, gathering important information in order to develop the best work possible. The evaluation of the evolving fidelity prototypes allowed us to understand if the system meets the users' needs. To finish this chapter, and as a way of organizing the different stages the work presents, a Gantt chart was presented, which helps to visually understand the various phases of the work.

4. Analysis of the problem

This chapter presents the work conducted in the project development stage. The work carried out in this stage started with the recruitment of participants and includes the interviews, personas, photo elicitation. Each phase describes how it was prepared, when it was developed, the participants involved (when applicable), the context in which it occurred, what materials or technologies were used, the results and key learnings that emerged from that phase, and how they impacted the design.

4.1. Storyboard

In order to help visualize the user experience with the proposed project and understand the possible interactions, a storyboard was created (Figure 17)[15]. The storyboard starts with Amélia experiencing difficulty choosing an adapted bra to her specific needs after undergoing mastectomy. It is a hard task for her, especially because she recalls the elegant and variety of options she had prior to the surgery. After finding a garment personalization app, whose main focus is to offer undergarment options for women who have undergone mastectomies, Amélia starts to explore the app and the different options that are offered. For personalizing the desired undergarment, Amélia needs to create a 3D avatar based on her body. Afterwards,

[15] In Annex 3, one can find the first developed storyboard that suffered alterations after the first target was delivered. This adjustment was needed to be made because, unfortunately, the sensor Intel RealSense stopped being explored and making part of the project. The team only had access to the sensor in March and, before being able to explore with it, we only had access to the provided information online. After a thorough research, it was made noticeable that there was no available literature review regarding body meatrics. After researching and various attempts, it was concluded that the sensor only can measure in depth (z axis) and not between two points (x and y axis), as was intended.

Amélia can virtually try different bra options that the app provides. Besides this, Amélia also has the ability to personalize each bra, changing aspects, such as colors and textures.

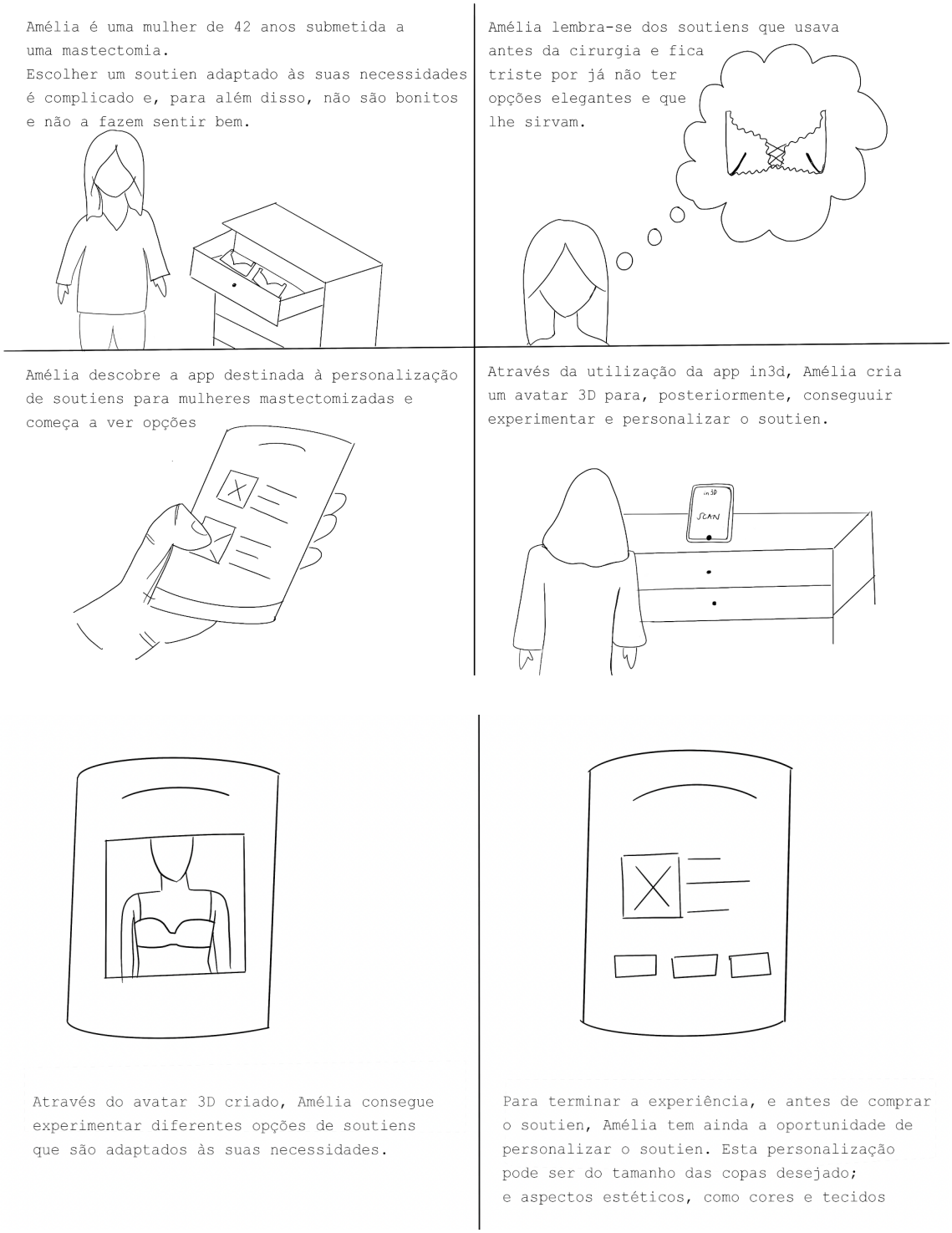


Figure 17 – Storyboard

4.2. Interviews

Interviews occurred from March until May, when seven participants were interviewed remotely. The interviews were video recorded and later transcribed verbatim. These transcriptions were essential for the subsequent thematic analysis and synthesized in an affinity diagram. Through thematic analysis, it was possible to group the key learnings by themes and then find common ground between all the different analyses. The transcripts and affinity diagrams that resulted from this process can be found in Annex 4 and Annex 5, respectively.

Recruitment

As stated previously, the participants recruited for the study were divided into two groups:

1. **Women** who have **undergone mastectomies**;
2. **Health care professionals** who work with breast cancer survivors, such as **doctors** and **psychologists**.

The recruited women only had to be breast cancer survivors who have undergone mastectomy. The important part is having experience in buying bras after the procedure and the impact that the mastectomy causes, not only physically but also psychologically. For the health care professionals, the criteria was to work in the oncological field, especially with breast cancer patients.

To find people relevant to the project, two approaches were used. The first was contacting the Núcleo do Centro da Liga Portuguesa Contra o Cancro, an organization with headquarters in Coimbra. After various attempts to get in touch with the organization by email and phone, a positive response was not obtained, and it was not possible to locate women who have undergone mastectomies. On the other hand, the Liga Portuguesa Contra o Cancro provided contacts of two health care professionals, one doctor and one psychologist.

We then resorted to our personal contacts and networks to recruit study participants. The first recruited participant, one woman who has undergone mastectomy, was recruited through personal contact. It was revealed to be a good way to create a solid network, since different people would know more people that could be relevant to the study. Through the network created during the recruitment phase, it was possible to pinpoint participants for the interviews and the adjacent photo elicitation activity.

Choosing the healthcare professionals was a task that needed to be well thought out, in order to recruit professionals that made sense for the project. To recruit a psychologist was crucial, since the proposed work tries to understand the impact the mastectomy and the underwear options for post surgery have on women who have undergone this procedure. It made only

sense to recruit, at least, one psychologist as a way of gaining reliable information regarding this aspect.

To complement the knowledge gained from the literature review stage, regarding breast cancer and mastectomy, it was decided that interviewing a doctor and a nurse would be of the best interest. These two professionals have the ability to offer input on the physical impacts of the mastectomy, connecting with the psychological ones as well. Besides, they can also provide accurate information about the functional aspects that the bras for women who have undergone mastectomy need to have, since this project aims to design a bra model for women who have undergone mastectomies. Connecting this with the desires and needs shared by the recruited women, it is possible to truly understand how the bra needs to be.

After the recruiting process was completed, the total number of participants was:

1. Four women who have undergone mastectomies;
2. Three health professionals: one psychologist; one doctor; and one nurse.

Procedures

The preparation for this phase started by deciding on the main topics to be approached during the interviews, for which an excel chart was created (Table 2, Table 3 and Table 4). The table was divided according to the groups of participants: the women who have undergone mastectomies (Table 2), doctors (Table 3) and psychologists (Table 4). Afterwards, the topics to be explored, and the possible questions to use while conducting the interviews were listed, allowing us to have a solid idea of the topics explored and simplify the creation of the interview script. The script was divided into the following topics:

a. **Mastectomy**, with the purpose to understand the physical and psychological impacts of the mastectomy;
b. **Clothing and buying experience**, after the mastectomy, focusing on underwear and bras. Within this topic we aimed to understand frustrations, needs and desires when it comes to buying bras after the mastectomy. We also wanted to understand what women felt when going to stores and asking for help, to figure out whether they felt comfortable or instead that was still a big challenge. This topic was only explored with the interviewed women who have undergone mastectomy, since it was very personal to their experiences. The second topic to be explored with the health care professionals, focused on underwear options for post mastectomy, especially bras, and aimed to understand how a bra for women who have undergone mastectomy should be, mainly when it comes to functionality.
c. **Underwear after the mastectomy**, to explore the different needs when it comes to finding bras after the mastectomy. This topic was only explored with the health care professionals, since they could give good input on how the post mastectomy bras need to be, functionality wise. This helped understand why the bras need to have certain functional aspects, beyond the aesthetic point of view.

Participant	Topic	Questions
Women who have undergone mastectomy	1. Social & demographic	a. age b. what age were you when you got diagnosed?
	2. Mastectomy	a. before undergoing a mastectomy, what other treatments did you tried? b. what where the main adjusts you needed to have after the mastectomy? c. mentally, how do you think the mastectomy affected you? d. why didn't you chose to have a breast reconstruction surgery?
	3. Clothing and Shopping Experience	a. how did the mastectomy affected the clothes you use? b. before the mastectomy, how was your shopping experience? (online, in store, looked for help, easily, when needed, etc)? c. when buying a bra, what are attributes you look for? Purely functional or aesthetical as well? d. when it comes to shopping for undergarments, do you go in-store or feel more confortable buying online (employees don't see you, don't have to explain the situation, etc.)? e. what do you think of the options that are on the market, when it comes to undergarment options for women who have undergone mastectomy?
	4. Likert scale questions	a. do you agree that well fitted and beatiful options of bras impact, positively, the self-esteem? b. the bra options for women who have undergone mastectomies are not the most elegant and beautiful ones c. and what are the implications of having an adapted and beautiful bra for these women? d. having an app that allows people to choose, try, personalize & buy bras online is an advantage.

Table 2 - Excel chart for organizing the interviews with women who have undergone mastectomy

Participant	Topic	Questions
Doctors	1. Social & demographic	a. age b. medical specialty? c. for how long have you been working with breast cancer patients?
	2. Mastectomy	a. main physical impatcs b. main psychosocial impacts c. what are, in your opinion, the main reasons women opt for not have a breast reconstructive surgery? d. special cares women need to have post mastectomy (clothing wise)?
	3. Undergarment in post mastectomy	a. what are the functional aspects a bra needs to present, when it is created for women who have undergone mastectomies? b. what is the ideal bra for after a mastectomy? (padding, rims, etc) c. are you aware of the undergament options that women have? d. if so, what do you think of them (functional and aesthetic aspect) c. after the procedure, what kind of advice do you provide women regarding undergarments, in particular bras? The advice you give them is in what form? Do you give them leaflets, advice during a conversation, etc? d. taking into consideration the undergarment options, especially bras, for women who have undergone mastectomy, what is your opinion about them? do you believe that they are good options, functionality wise (no underwires, padding, etc). And when it comes to aesthetics (although it's not your field of expertise), what do you think of them? Beautiful and elegant options, that makes women want to buy them?
	4. Likert scale questions	a. do you agree that well fitted and beatiful options of bras impact, positively, the self-esteem? b. the bra options for women who have undergone mastectomies are not the most elegant and beautiful ones c. and what are the implications of having an adapted and beautiful bra for these women? d. having an app that allows people to choose, try, personalize & buy bras online is an advantage.

Table 3- Excel chart for organizing the interviews with doctors

Participant	Topic	Questions
Psychologists	1. Social & demographic	a. age b. medical specialty? c. for how long have you been working with breast cancer patients?
	2. Mastectomy	a. psychosocial impact b. psychologically, why do you think women chose not to have breast reconstruction surgery? c. what kind of psychological impacts are most common amog women who need to remove their breasts? d. what are the biggest concerns before and after the procedure, for women? e. and the biggest struggles? *f. enclothed cognition (explain it and open space for discussion?)*
	3. Undergarment in post mastectomy	a. the impact of well fitted and beatiful options for the self-esteem. b. what are the implications of having an adapted and beautiful bra for these women?
	4. Likert scale questions	a. do you agree that well fitted and beatiful options of bras impact, positively, the self-esteem? b. the bra options for women who have undergone mastectomies are not the most elegant and beautiful ones c. and what are the implications of having an adapted and beautiful bra for these women? d. having an app that allows people to choose, try, personalize & buy bras online is an advantage.

Table 4 - Excel chart for organizing the interviews with psychologists

The scripts were slightly adapted when interviewing both groups. The next section presents the analysis of the interview results.

Results and analysis

After conducting all seven interviews, there were approximately four hours of recorded interviews to transcribe and analyze. Each interview took no longer than thirty minutes. For the analysis of the gathered data, an **affinity diagram** was developed (Figure 18). Affinity diagrams are a good way of organizing data in a structured way, making it possible to find patterns between the different participants. **Three levels** were created, with five different thematics:

- **First level** involved exploring the **mastectomy**, the procedure and the impact it causes on women;
- The **second level** regarded **clothing and underwear**, focusing on bra options for post mastectomy women;
- The **third** and final **level**, explores the **psychological impact** of the mastectomy in women and how fashion can play an important role in the mental state of women. Here, the term of **enclothed cognition** was debated with the participants.

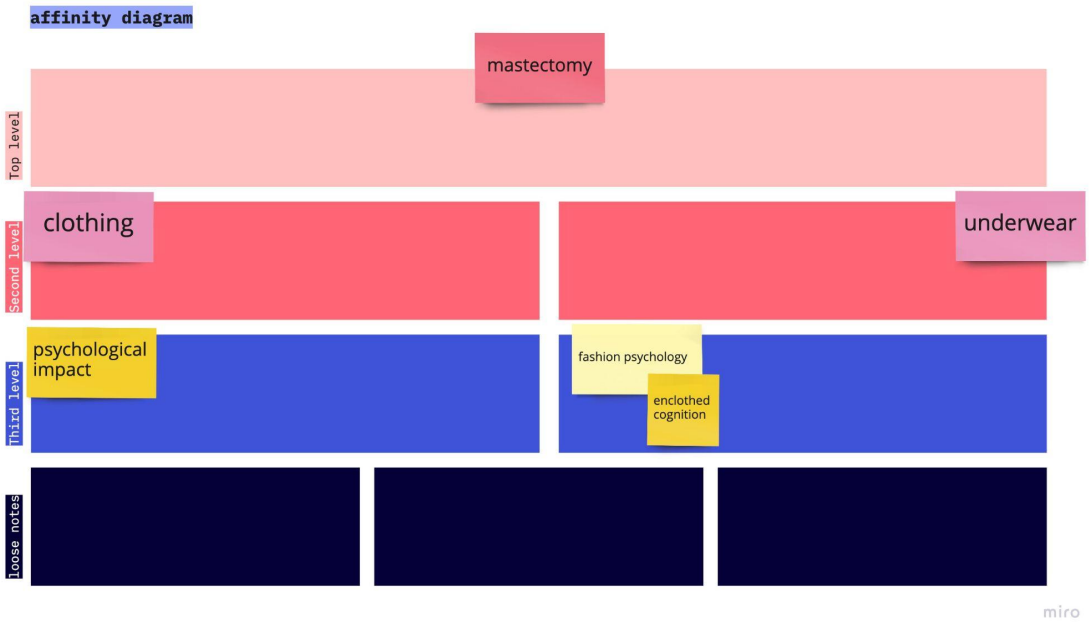


Figure 18 - Affinity diagram divided into levels

Through the interviews, it was not only possible to confirm concepts presented in the literature review, such as the importance of breasts in society and the roles attributed, and the psychological impact the mastectomy produces on women, linked as well with the physical ones; but also to gain an in-depth understanding about the specific needs, desires and frustrations women have in the post-mastectomy stage and the bra options available to them. To conduct the interview analysis, each of the interview groups was analyzed separately, as detailed next.

4.2.1.1. Results and analysis of women's interviews

As mentioned before, the analysis followed an Affinity Diagram approach, organized through different levels and themes. Having an affinity diagram (Annex 5) that condensed all the obtained information and presented the common ground between all four interviewed women, was crucial to retrieve the presented results in this part of the document. The **first level** focuses on learning about women's particular experiences with **breast cancer and mastectomy**. The majority of the interviewed women (three out of four), went through both chemotherapy and radiotherapy as another way of tackling breast cancer. And, although women lost a very important area of their body, they understood the necessity of the mastectomy and viewed it as a blessing and a cure. It was also interesting to understand that the majority of women, three out of four again, did not feel it was a big loss, as one of the participants shared, "I did not suffer such a big loss, I just wanted the other (breast) removed". Again, they know how important it was to have the mastectomy and prevent any recurrence of the cancer cells. When it came to talk about the **psychological impact** of the mastectomy, women all commented how their only concern was to get rid of the cancer cells, regardless of losing one, or both, of the breasts. Another aspect that women talked about was motherhood. The interviewed participants that were already mothers, and went through the breastfeeding phase, felt that that made it a bit easier to deal with the mastectomy. One woman even stated that she "thankfully, was able to breastfeed for many years." She also is aware that she "had fulfilled the function for which they (breasts) were designated for. It is not just an aesthetic aspect, it is also the process of sharing with the children. The feeling of giving was very important".

The **second level** comprises **clothing** and **underwear**, focusing here on bra options for the **post mastectomy stage**. In terms of clothing, all of the interviewed women mentioned that they take special attention to cleavage. Besides this, women also avoid wearing tight fitted clothing, mainly tight tops. Women do not feel comfortable drawing attention to the chest area after the mastectomy, so they opt to wear more loose and flowy tops. It is not an easy task to find pieces of clothing that fit properly, after the mastectomy, as two women mentioned. The way that the fabric falls on top of a prosthesis is very distinct from the way it falls on the natural breasts, which makes the process even harder. And the same happens with finding bras and bikini options, since they need to have certain specificities. Two women commented that the bras they used after the mastectomy were uncomfortable and felt very tight on their chest, although the bras were the right size. One of the participants shared: "What happens is that the bra feels very tight. The bra is my size, and everything, but it is very uncomfortable. And I feel more comfortable with gym bras".

If women have a smaller chest, as three of the interviewed women referred to, it is a bit easier to find options or to adapt existing ones. But still, it is very difficult to find good, functional and beautiful options. All interviewed women commented that the available bra options for post mastectomy women are neither beautiful nor elegant. "What exists (bra options) are not pleasant", "They (bras) are only remediable options. It is very trivial", are two of the

sentences shared by the interviewed women and that encapsulate the feelings the participants have towards the existing bra options. These affirmations also support one of the main ideas behind the proposed work, and that it is intended to address the stated difficulty.

With the interviews, it was possible to learn about what women really look for when there is the need to buy a bra. The unanimous functional aspect that the interviewed women referred to was the need for bras not to have underwire. Besides this functional aspect, women also indicated the following:

- Bra with **side pockets** to put the prosthesis on;
- **Wider** bra **strap**;
- **Practical** bra.

The last part of the interview consisted in opening up the space to exchange ideas about the concept of **enclothed cognition**, presented previously in this document in section 2.2.1. All four women "totally agreed" with this concept, claiming that clothes have the power to impact one's self-esteem. Clothing is perceived as a way of communicating, and even colors can affect the way women feel and their self-esteem. One woman said that bright red made her feel like herself and confident, and another one said that black was her safe choice when she needed to feel good. "It may be dark, people may say it is connected with sadness, but it makes me feel good". The interviewed women stated that they liked to get ready, and chose pieces of clothing that made them feel good about themselves. One thing that these women referred to was the fact that they like to get ready for themselves and not for others. "It is not for the others, it is for me, to feel good", as one participant confessed. They use fashion, and clothing, as a way of positively promoting their self-esteem, to feel good about themselves, and not to please other people.

The other outcome from the interviews with the recruited women was the creation of two personas (Figure 19 and Figure 20). As stated by Mike Kuniavsky (2012), "a persona is a user archetype (...), not a real person, but a synthesis of facts and observations about real users that leads to a memorable character". In the context of this project, it was important to define personas in order to capture women's needs and desires, as well as to gain more empathy with them. The personas created were developed and refined based on the information collected from the interviews. The names of the personas are fictitious, but the remnant of the information is based on the interviewed participants.

The created personas represent two different types of women who have undergone mastectomies: women who had undergone mastectomy a few years ago and ended up having breast reconstructive surgery; and women who had undergone mastectomy recently, and are still trying to adjust to the changes. The first description of women are represented by Alice Gama (Figure 19) and include positive feelings towards the surgery, the familiarity with the situation, but still the struggle it is to find an adequate bra. The second persona, Teresa Soares (Figure 20), describes a woman who had undergone a mastectomy recently and is still adjusting to the various changes. Besides this, it represents the part of women who try to

overcome the obstacles of not having bras that fit correctly and are beautiful, by altering different options and making these more their personal style. To visually create the personas, we used Figma and the open source plug-in "Humaaans for Figma"[16] by Pablo Stanley.

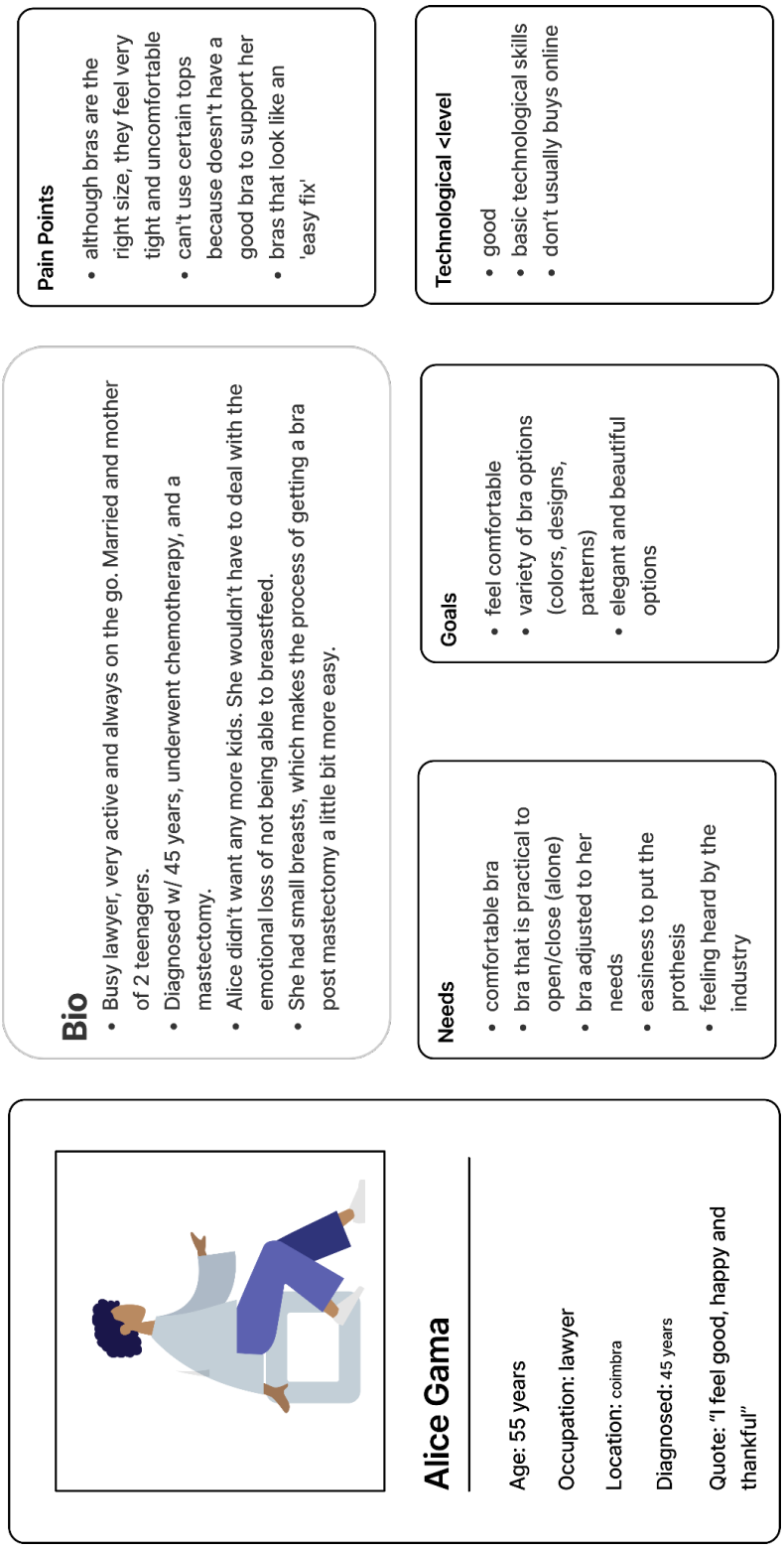


Figure 19 - Persona Alice Gama, woman who undergone mastectomy

[16] https://www.figma.com/community/plugin/739503328703046360/Humaaans-for-Figma

Teresa Soares

Age: 35 years

Occupation: interior designer

Location: aveiro

Diagnosed: 32 years

Quote: “It is hard to find bras that fit”

Bio

- A creative interior designer, that uses creativity in her life, when needed.
- Diagnosed with only 32 years, undergoing a mastectomy shortly after.
- It was very hard to find bras that propely fitted, after mastectomy, since she had a bigger chest.
- Being really creative, Teresa used her sewing abilities to alter bras she liked to fit her better

Pain Points

- going to the store can be difficult (and explain the situation to the workers)
- can't use the bras offered by Liga Portuguesa Contra o Cancro. They are very tight
- looking at the mirror is hard (post-mastectomy)

Needs

- comfortable bra
- possibility to buy online
- option that allows her to use more light fabric clothing and still feeling supported
- ability to remove straps

Goals

- wants to feel good with her body again
- ability to chose from different options
- ability to chose from different options

Technological <level

- very good
- it's familiarized with 3D environments
- prefers to shop online

Figure 20 - Persona Teresa Soares, woman who undergone mastectomy

4.2.1.2. Results and analysis health care professionals' interviews

Interviewing health care professionals that work side by side with post mastectomy women was a way of getting in-depth knowledge of the procedure of the mastectomy and how it affected women. Again, the analysis of the collected data was organized through an affinity diagram (Annex 6), based on the already presented levels.

The **first level** focuses on the knowledge collected about **mastectomy**, such as the procedure, the physical impacts and the recovery process. The mastectomy is a long and painful path, as stated by all the interviewed health care professionals. "It is not only the mastectomy, they (women) go through chemotherapy and radiotherapy sessions. It is a long and painful process", as one participant explained. It is a process that involves various surgeries, radiotherapy and chemotherapy, and a very challenging scarring process. There is also the loss of a very important area of the female body, with a huge physical impact. This is utterly connected with the psychological impact, as one participant explained "I think that it is impossible to dissociate the physical part from the psychological one. And the breasts, for women, always have various symbols, such as of femininity and motherhood".

The **second level** presented on the affinity diagram is connected with **clothing**, especially **bras**, in the **post mastectomy** stage. When it comes to **clothing**, all of the interviewed professionals agreed that women need to take special attention when it comes to cleavages, due to the prosthesis, scarring and even skin irregularities after treatments. Other aspects that were mentioned, and which are particularly relevant to this research, are:

- Avoid tight fitted tops;
- Caution with synthetic fabrics and seams, since they can cause irritation on the skin or the scar;
- Caution with colors and fabrics, so they don't transfer to the skin, especially to the scar.

When questioned about **bra options**, the three health care professionals highlighted the necessary functional aspects that bra options need to have in order to be considered a good bra:

- Bra with **support** for prosthesis, such as a **side pocket**;
- Bra **without underwire**;
- Take special attention to the **fabric quality**, trying to opt for cotton since it is, usually, more comfortable;
- Bra that **opens in the front**. It is very practical, not only for placing the prosthesis, but also because women have a difficult time to rotate their arms and upper body after the mastectomy, so closing the bra in the back can be very hard and painful;
- **Larger bra straps**, helping to support the prosthesis and avoid to cause any harm on the shoulders;

- Bra with a **taller cleavage** can be a good option for women that have scars on the sternum or dots in that area from the radiotherapy.

An important aspect that the interviewed doctor referred to was that lace is not a viable option when choosing a bra, as lace is, most of the time, a synthetic fabric. A type of fabric that can have serious implications in a more sensitive skin area, such as the chest after the mastectomy, ending up by causing irritability. Another thing is that lace does not provide good support for the prosthesis used by women. This is interesting, since lace is usually perceived as an elegant option for fabric and women tend to like it for underwear pieces.

Connecting the **physical impact** with the **psychological** one, and being this the **third level** of the affinity diagram, it is possible to notice how the mastectomy affects women and their mental state. **Psychologically**, women face various challenges. The one aspect that was pointed out by all three interviewed health care professionals was the decrease of the libido and sexuality, something that can take a big toll on relationships with partners. One of the interviewed participants recalled some episodes of women who felt that people, especially their partners, started to look differently towards them. The doctor contributed with her opinion on this subject, sharing what women who have undergone mastectomy felt: "(People) don't look at me in the same way, my husband does not look in the same way (...) So, there is a strong psychological impact". This impacts greatly when it comes to women's self-esteem and the way they perceive themselves. The relationship women have with their body drastically changes, with a negative affected self-esteem and self-concept. This happens, mainly, because women feel that something is missing, and do not feel like themselves. And some women have even a deeper sense of loss, feeling amputated. There is a long process of accepting the new body image, a process that can be eased out by having the right help, such as psychologists. The interviewed professionals understand that women "feel the loss of one organ that, although is not physically vital, it is for the appearance and self-esteem", especially due to the various meanings and roles that breasts have in society, such as: femininity, motherhood, sexuality, and even distinction between sexes (biologically speaking).

The interviewed psychologist stressed how important it is to be honest about what the woman is feeling, in order to help during the healing process, "Without a doubt, one of the main pieces of advice given is for women to share and be honest with how she feels". Women also fear the resurgence of cancer cells, so they accept the mastectomy as part of the cure process. Women develop an aversion to the oncological environment, being this one of the reasons why women opt for not having breast reconstructive surgery.

When introduced with the concept of **enclothed cognition**, the interviewed health care workers were parted, since they could not generalize something like this, being style and fashion very personal to each individual. But, it was possible to conclude that clothes do have the power to affect the mental state, energy and attitude towards life. Clothing can also help to perceive the mental state of the wearer, it "influences the state of the person. The psychological state, the posture of the person. The energy it presents towards life (...) In my

work, I try to even use clothes to understand the psychological state of the person", as shared by the nurse. The same participant gave an example of someone who was dealing with depression. In this case, it was possible to notice that something was not well since the person stopped caring for her appearance, presenting herself in very wrinkled clothes, for example.

Implications for design

After analyzing the interviews, first individually, and then divided by groups of participants, it was possible to synthesize the key learnings and find common ground between the two groups (Annex 7). These key learnings were then taken into consideration in the design stage of this project.

When talking about clothing, it was clear that buying pieces of clothing after the mastectomy is difficult, especially underwear and swimwear. After the interviews with the participants, it was understood that the bra model that was created had to respond to certain demands and needs from women who have undergone mastectomy, such as:

- **Side pockets** for the prosthesis;
- **Taller cleavage**, helping to hide the scar;
- Bra **without underwires**;
- **Wider bra straps**;
- **Quality fabric**, usually **cotton** and pay extra attention to lace. If there is lace, at least don't be in direct contact with the skin.

These aspects were the ones that guided the design of the bra model and can be encountered in the final prototype of the 3D bra model, present in section 5.1 - 3D modeling. These considerations were also supported by the interviewed health care professionals.

The interviewed women all feel that the industry has normalized bra options for women who do not have to deal with a mastectomy, making it harder to find various options for women who have undergone this procedure.
With regards to the enclothed cognition concept, it was not possible to achieve common ground. While women considered this concept to be a reality, and could connect with it, health care professionals preferred to relate it to something that can be different for each person than to generalize. Besides this, it was possible to understand that all of the interviewees agree with the fact that clothing can be a way of communicating and positively impact self-esteem. This can be translated into the offered option of bras for women who have undergone mastectomies, combining the functional with the aesthetic elements, making women feel good about themselves and help with their self-esteem.

4.3. Photo Elicitation

After conducting the interviews, we were able to start with the proposed activity, connected with the participatory design approach chosen to be followed. It is in this stage that the photo elicitation activity is presented. The main goal of this activity is to promote communication with participants, resorting to pictures to guide the conversation. It is also intended for participants to share personal experiences, feelings and thoughts regarding mastectomy and bra options available. As stated previously, the already recruited and interviewed women participated in this activity.

Procedures

After conducting the interviews, we were able to start with the photo elicitation proposed activity. Photo elicitation promotes communication with participants, resorting to pictures to guide the conversation (Kuniavsky et al., 2012, p. 232). In this work, the photo elicitation was intended for participants to share personal experiences, feelings and thoughts regarding mastectomy and bra options available. The participants of the photo elicitation activity were the same as those interviewed.
Procedures
The preparation for this activity started with the creation of a table (Table 5) to organize ideas and goals for this activity. The table is divided by:

- Possible questions to be asked during the activities;
- Goals of the activity;
- Procedure and preparation;
- Data collection;
- Analysis of the data.

Possible questions	**Goal(s)**
What do you think in this photograph represents what we have been discussing in this project?'	use photos as a guide, stimulus, and triggers for conversations photos that help describe the experience of post-mastectomy and bra choices explore **thoughts and feelings** about the presented photographs, and how they **represent** the **participants experience** discuss possible difficulties participants might have encountered
After going through the photos and pondering about them, can you establish a connection between the photos and the topics we have been discussing in the project?	
Do the photos somehow represent your personal experience? If so, to what extent? Do the photos represent what you have been through? If so, to what extent?	
Procedures & Preparation	Data Collection
- collect photos online and put them together in a presentation to show in the online meetings - process of selection and exclusion of photos - auto-driving interview: the participant chooses what photographs wants to discuss and leads the interview. researcher adopts the role of active listener - have some questions/topics to guide the interview, if necessary - capture verbal and visual information	- the selected photos encouraged the discussion with participants? - how many photos were selected? - how long for each photo? - was there a train of thought? did the participant followed a certain logic to express thoughts and opinions? - how many women participated in the activity? - how long was the activity? - did womem provided any other example? visual or only talked?
Analysis	Themes to be explored
Polytextual thematic analysis (meaning is explored by moving back and forward between the data sets rather than seeing them as separate) **Thematic analysis**: identify themes that emerge from the data. Searching through a data set to find repeated patterns of meaning	- breast cancer - bra personalization - psychological impacts of mastectomies, namely on your body image

Table 5 - Table created for organizing the photo elicitation activity

As a way of guiding the search for images, it was decided to focus the activity on the following themes:

- **Breast cancer**, **personal experience**;
- **Breast cancer**, **psychological impact and body image**;
- **Bras**, before and after the mastectomy.

With the themes defined, it was possible to start searching and collecting different photos for the activity. We searched the web for pictures and retrieved 17 photos. After a review process, thirteen photos were selected, which met the goals we set-out to achieve.

The activity is intended to be guided by the participants. This means that the participants would choose what photos they would like to talk about and conduct the activity, being the researcher an active listener. For this purpose, a small presentation was created (Annex 6), in order to be shared with the participants before the activity. This way, participants were able to take a first look at the photos and the different themes, deciding the course they wanted the activity to take, such as deciding the order of the photos to be debated. The photo elicitation activity took place on the online platform Zoom, making it possible to record the meetings. This activity was planned to take no longer than fifteen minutes, something that was possible to achieve. For the analysis, an affinity diagram was used. The three thematics mentioned

above served as segments for the thematic analysis. The next section shares the results of this activity.

Results and analysis

The activity started with exploring the broader theme, breast cancer and the personal experience, and then became more specific at each stage, ending with bra options before and after the mastectomy. The activity was recorded, as a way of helping in the analysis process. Data were first transcribed and, afterwards, analyzed. This section presents and discusses the obtained results.

a. Breast Cancer, personal experience

When it comes to the mastectomy procedure and the personal experience of each woman, it was valuable to understand that the participants did not feel shocked when looking at scars shown in the photographs, and feel the same way towards their own. All the participants remembered how hard the recovering and scaring process was, and even how horrible it looked. Still, women can look at the scar and have a positive attitude towards it. Although it was a challenging process for these women, they all faced it as a cure, something to be grateful for. Although there were some torn ideas regarding this positive attitude, some women feel like not having a breast is an achievement, not something that is missing, as one participant stated “the lack of the breast was not exactly a lack, but more of an achievement”. On the other hand, some women feel this absence towards something, being left with an odd feeling of just having one side, or none, of the breast. It is possible to link these feelings, expressed by the participating women, with the already presented literature review. The authors Koçan and Gürsoy express those same concerns and thoughts when sharing that the opinions of women who have undergone mastectomy shift between being “grateful to still be alive and saw this as more important than the loss of a breast” and experiencing “great sadness at the loss of their breast”, (2016, p. 147).

When faced with the picture of women showing off their scars in such a light mood (Figure 21), the participants did not feel uncomfortable. They all thought how beautiful the photo was, and how comfortable women felt with their new body, “facing the missing of one breast with courage”, as one woman said. There are beautiful ways of showing the new body, telling a new narrative, helping women to find a way of feeling confident and beautiful.

Figure 21 - Image used in the photo elicitation activity

Something that women recalled as being very hard to go through was the constraints they felt on their upper body, due to the extraction of the lymph nodes. This made the recovery process even harder, affecting not only physically, but also psychologically. It requires "a lot of willingness to turn the situation around and regain the previous mobility", as one of the participants recalled. In short, we concluded that the interviewees cannot disassociate the physical from the psychological, being both affected after undergoing a mastectomy.

b. Breast Cancer, body image and psychological impact

Following the train of thought of having a positive mindset towards mastectomy, women feel like they do not have the need to hide their new body, after the healing process. But, although the participants appear to have a positive attitude, it is still a troublesome process to deal with. And "no matter how strong a person is, it is still hard to look in the mirror", as stated by one of the participants. The same participant shared that "the first time you look in the mirror is odd, although it is not something new, since I was aware of the change". But something that was more challenging for some of the interviewed women (2 out of 4) was touching the affected area, specially the scar. Another participant even said that she "did not imagine that that was going to happen".

When confronted with a photo of a woman looking in the mirror and putting makeup on (Figure 22), the majority of the participants (3 out of 4) confessed that they started to pay more attention to taking care of themselves, for example putting makeup on, because it was something that made them feel good. Besides, it was a way of not looking so sick. One of the participants even recalled one unpleasant interaction with a person that made a lot of questions about her looks and health, making her feel very uncomfortable about her image. We concluded that after the mastectomy, it can be hard to look at the new body and the new reality, as stated previously, being very easy to ignore personal desires and ways of being in life.

Figure 22 - Image used in the photo elicitation activity

The same image (Figure 22) worked as a prompt for discussing hair loss and how women dealt with it. Only two women shared their personal experience regarding hair loss, and both did not identify with wearing a scarf, opting for a capilar prosthesis. One of the participants even said she only wore the capilar prosthesis because of the patients in her work place. She had the impression that the "patients did not feel very comfortable if she wore a scarf or if she was bald". Both women confessed they did not feel comfortable with the capilar prosthesis, and only wore it for work purposes.

In this activity, it was possible to debate the feeling of losing one, or both, breasts. It was also possible to learn how even some women felt they had a part of the body being amputated. It is something that has a big impact on the mental state of each woman. Let's not forget the way breasts are perceived in society, being utterly connected with femininity and motherhood.

When asked to share the personal experiences regarding going to stores after the mastectomy, and asking for help, 3 of the 4 participants sustained that they did not have any trouble in going to the stores and asking for help. If it was something they needed help with, they just asked for it. Although they recalled some difficult encounters, where the shop collaborators felt a bit uncomfortable with the situation, something that was easily overcome when the collaborated understood that the woman was comfortable with the new reality, as one of the participants shared.

c. Bras, before and after mastectomy

The last theme to be explored in this activity with the participants was bra options, before and after the mastectomy. Initially, when confronted with an image from a regular bra (Figure 23), women felt frustrated because, since prior to the surgery, it was easier to find good options. One woman even stated that the photo worked as a "rupture with the old life and with the old bra options". And even with a smaller chest, it is challenging to find good options. The same woman also talked about the importance of the prosthesis and the impact it has on the posture. She stated that "the prosthesis is important (...) it was sorely missed in lumbar terms. In terms of posture (...) The tendency to lift the shoulder from the side that doesn't have the breast is impressive. I only noticed it later".

Figure 23 - Image used in the photo elicitation activity

Looking at another photo of a regular bra (Figure 24), not tailored for women who have undergone mastectomies, made the participants share why they cannot wear those bras and the functional aspects needed. The shared attributes were:

- **No underwire** or **padding**;
- **Wider bra straps** and, if possible, **adjustable** ones;
- **Higher front panel**, for covering eventual scars and for supporting prosthesis;
- **Opening** in the **front** is helpful, due to the limitations of movement and for placing the prosthesis.

Figure 24 - Image used in the photo elicitation activity

The following photo (Figure 25) was triggering for some women, because they looked at something so beautiful and elegant that they did not even consider it a viable option for them. One of the participants even confided that “this did not look like an option of post-mastectomy bras, just because it is something so beautiful”.

Figure 25 - Image used in the photo elicitation activity

The last shown photo (Figure 26), a full lace bra for post mastectomy, was something that initiated a good discussion. Although women thought it was a beautiful bra, they had their doubts towards the comfortable levels. First, they stated it is best if the bra is not completely transparent, like the one from the photo. Otherwise it will show the scar and women do not

feel comfortable with it. Then, lace does not offer the necessary support for the prosthesis. Lastly, women who have undergone mastectomy need to take special attention to the fabric quality. The chest becomes very sensitive and needs to be protected, this is why cotton is the best option of fabric, over lace.

Figure 26 - Image used in the photo elicitation activity

Implications for design

After analysing the four interviews of the photo elicitation activity, through the thematic analysis previously presented and explained, it was possible to find the key learnings that will be taken into consideration in the design stage, in particular the modeling of bra alternatives.

The activity allowed us to get to know better, and on a deeper level, the personal experience each woman has regarding mastectomy and breast cancer, confirming the implications mastectomy has on the body image, also affecting the psychological state. Lastly, but not less important, we could confirm the belief we had regarding how the interviewed women feel towards the bra options that the market offers for post mastectomy women, feeling that there is a rupture with the old life and the previous bra options. **Women do not like the options they are offered** in regular places to purchase bras, places that offer more affordable options. Besides, women did not associate the beautiful and elegant options with something they could choose and wear. Again, this corroborates one of the main opinions of the present dissertation, where **bra options for women who have undergone mastectomy** are **neither beautiful nor elegant**, being intended to fight this encountered problem. With this information in mind, the designed bra model was thought to, at first glance, not be associated with a post mastectomy bra. This was achieved through the textures chosen, colors and the overall shape of the bra. Once again, in section 5.1 - 3D modeling one can find the final prototype of the 3D bra model.

4.4. Chapter summary

This chapter made it possible to confirm and add to the knowledge constructed based on the literature. This chapter also reports on the work with end-users, which allowed us to gain more insight about the impact a mastectomy has on women. Working side by side with women was important to understand the real needs women have towards bras. These learnings are crucial for the next stage of the development, the design phase.

When it comes to the developed activities, it was concluded that interviews and photo elicitation produced different knowledge. The conducted interviews gave more insight to understanding how women dealt with mastectomy, the options they were offered and what they need and expect to have when choosing a bra. The photo elicitation activity was a way of getting into a deeper conversation about the mastectomy, the recovery process and the implications it has, both physically and mentally. It turned out to be an activity that truly explored the psychological side of the recovery process of a mastectomy, and also the new reality women need to deal with. Nonetheless, both activities were crucial to understand women's needs and desires, making it possible to start the individual design phase, described in the next chapter.

5. Visual design and modeling

The fifth chapter of this document presents the 3D modeling process and the visual identity for the proof of concept. The development of these items this was based on the previously acquired knowledge, from the various research stages. With the input of the participants, especially women who underwent mastectomy, it was essential to create a model of a bra that respects their needs and desires. It was also important to have a coherent visual identity as a way of properly communicating the goals and values of the product to the end users. Likewise, the section regarding visual design describes the different steps taken to define the typography, color, logotype, layout and grid and iconography.

5.1. 3D modeling

Different steps were carried out in order to create the 3D model of the bra. First, a series of paper sketches were made to better understand what to be put in the 3D model. After the low-fidelity prototype was completed, the process evolved to 3D modeling, using the blender software. The following sections provide a rundown of this process.

In order to start sketching the bra, it was crucial to take in consideration the data collected from the interviews and the photo elicitation activity. With this information, it was possible to understand what women who have undergone a mastectomy needed and desired, regarding bra options. When sketching options, the following aspects were considered:

- **No underwire**;
- **Inside pocket** for placing the prosthesis;
- **Wider bra straps**, especially at the top;
- Possibility to **open in the front**;
- **Taller cleavage**, in order to cover up the scar;
- **Comfortable fabric**;
- **Minimum padding**.

Alongside the functional aspects, it was also important to take into account the aesthetic attributes. As confirmed in the user research phase the participants, when it comes to bras, desire to encounter beautiful and elegant options, something that was already proven not to be an easy task. The aesthetic aspects that were taken into consideration were the following:

- **Without** the typical **postoperative look** (Figure 27);

Figure 27 - Example of postoperative bra

- With **lace**, if possible;

After collecting all the elements women shared as desired to be incorporated in a bra for post mastectomy, different alternatives were sketched. This was the chance to experiment with various formats, functionalities and designs. In annex 8, one can find the different sketches that were made before achieving the final paper prototype for the bra (Figure 28).

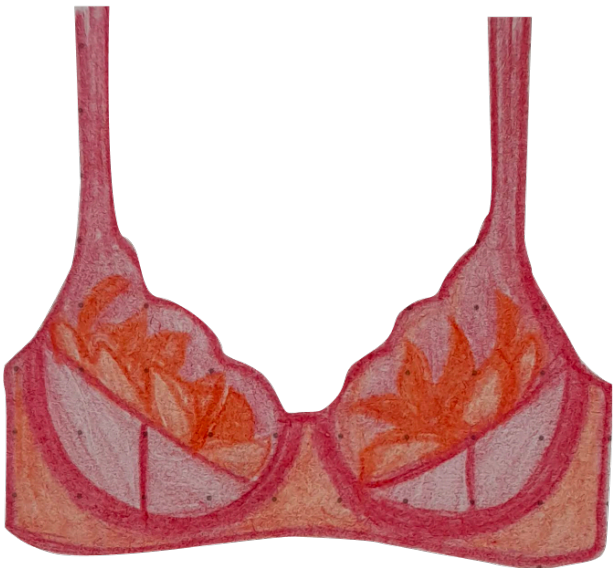


Figure 28 - Final low-fidelity prototype for the bra

Although in the sketches one cannot see the pockets for the prosthesis, placed inside the bra, and the opening of the same, these aspects were taken into consideration in the sketch phase. Regarding the options of the bra, it was decided to have a front opening, which is a practical option for women since:

- After the mastectomy, and especially if the lymph nodes are extracted, women cannot rotate and reach their back, making it hard to open the bra in the back;
- It is a practical way to adjust the prosthesis, if needed.

After finalizing the sketches for the bra model, it was time to move to the next phase of prototyping, the digital one. For achieving this goal, the 3D software blender was used. The first model that was prototyped, had both closing at the front and back. But, after analyzing the created version, we came to the realization that having one opening in the back and one in the front did not make much sense. A reevaluation of the specifications women shared regarding bras for post mastectomy, helped to refocus on the task of creating this 3D model. Likewise, the specifications that ended up being incorporated in the 3D model were:

- **Inside pockets**, as a way of helping with the prosthesis;
- **Front opening**, helping to adjust the prosthesis when needed. Also, it is very useful in the months after the surgery, where a lot of women deal with limitations of movement;
- **Taller cleavage**, for covering the scar and to help support the prosthesis;
- **Larger straps** in the shoulder area, offering more support;
- Possibility for **adjusting straps**;
- **No underwire** and **no padding** added, making sure it is comfortable to wear;
- Having special attention to the **selected fabrics**. Always **100% cotton** and, in the cases where lace is intended to be used, there is always a protective layer of cotton, making sure the lace and skin are not in direct contact.

With these aspects in mind, the created model is the following one, as shown in Figure 29. The different textures and colors that the bra can have, were tried out in the next phase of prototypes, the high-fidelity ones.

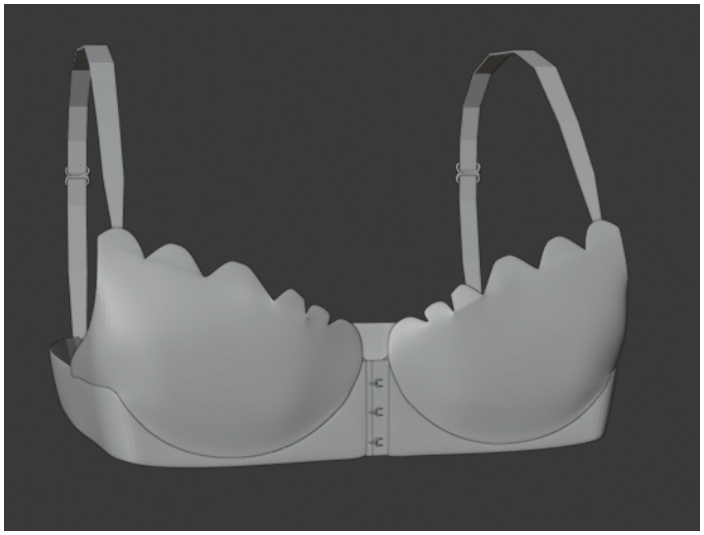


Figure 29 - 3D model of the created bra

Lastly, the 3D bra model gained textures and colors. Two different textures were used in the model, resorting to free textures available online. One of the textures resembles cotton[17] and the other presents a pattern that can be perceived as lace[18]. After, different colors were applied to the model (white, black and pink). Figure 30 shows the pink bra model with cotton fabric. In annex 10, one can find all the other colors and textures the prototype can present.

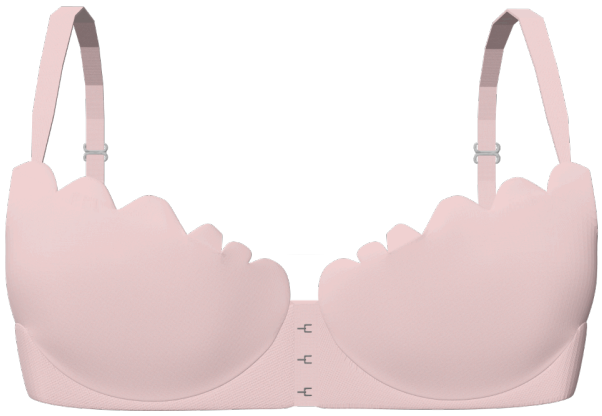


Figure 30 - Pink bra model with cotton material

[17] https://www.poliigon.com/texture/fabric-fleece-001/2332
[18] https://3dtextures.me/2022/06/20/fabric-lace-027/

5.2. Visual identity and style guide

Unlike previous stages, the visual identity and style guide were developed without the input gained through participatory design activities. The chapter describes the different steps taken to define the typography, color, logotype, layout and grid, iconography.

Typography

Resorting to text as an ally in an interface can be a good option, since "written language can convey dense and nuanced information" (Cooper, 2014, p. 410). Nonetheless, there is also the need to use text in a careful way, since "it also has great potential to confuse and complicate" the user, as explained by Alan Cooper (2014, p. 410). Typography ends up being what it is "between the author and the reader", ensuring the legibility and the readability of the text (Rutter, 2017, p. 4). With this in mind, one can understand the importance of choosing the correct typeface when designing a visual identity.

According to Alan Cooper, three main guidelines should be followed when resorting to text on an interface (2014, p. 410):

1. Opt for **high contrast text**, making sure that the "text contrasts with its background", aiming for 80% contrast. It is also advised not to use complementary colors, since they may affect readability;
2. Choose a **fitting typeface and size**, where sans-serif fonts are best used for readability. If the typeface size is less than 10 pixels, the readability can be compromised.
3. Decide on **succinctly written text**, achieving understandability by using "the fewest words necessary to clearly convey meaning" (Cooper, 2014, p. 410).

Considering the importance of choosing the right typeface for the proof of concept, it was decided to have two different fonts, Roboto Mono (Figure 31) and Montserrat (Figure 31). The distinguished fonts help to decipher the information hierarchy created. Both chosen fonts are sans-serif, since they produce a better result for legibility (Rutter, 2017). The main chosen font was Roboto Mono, used for headlines and subtitles. For small captions and body text, the complementary chosen font was Montserrat.

To help make the best decisions regarding the typeface, we resorted to Material Design[19], a system created by Google that allows the team to create a high-quality digital experience, such as interfaces. Here, different guidelines are presented as a way of helping in the design process. It used the type scale generator, a tool provided by Material Design that helps to establish type scales. These type scales can be applied to any font present in the Google Fonts

[19] https://material.io/

catalog, automatically resizing and optimizing each one, based on the Material Design typography guidance for readability.

Figure 31 - Main typeface Roboto Mono

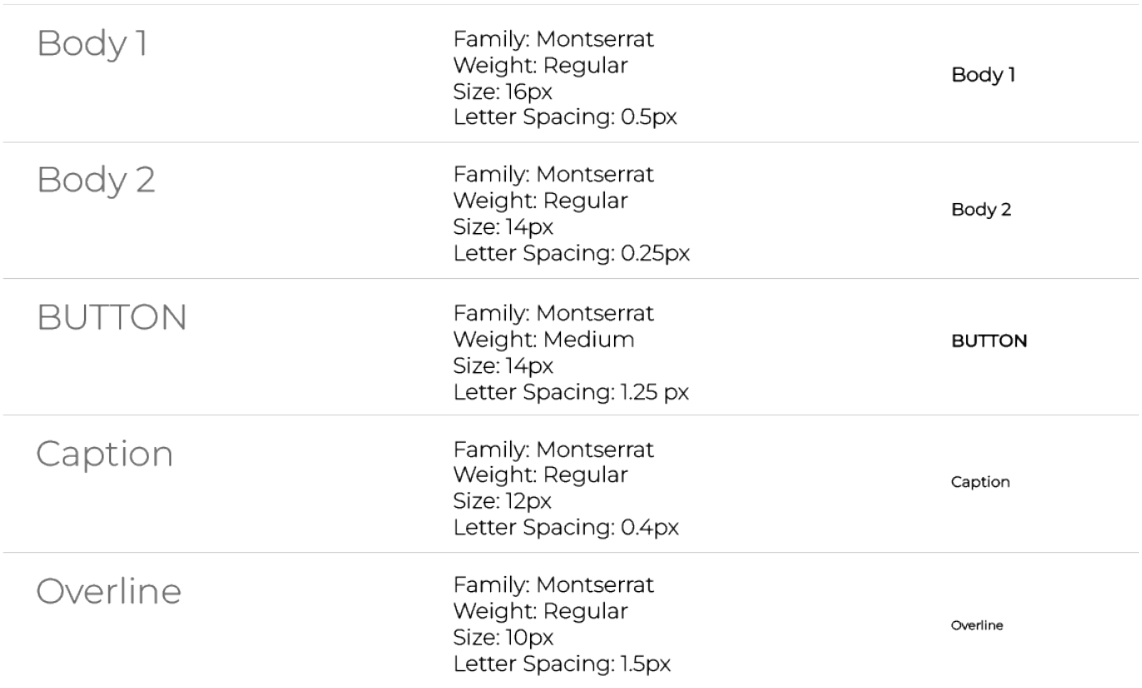


Figure 32 - Complementary typeface Montserrat

Color scheme

When choosing a color palette for a visual identity there is the need to “take into account the user’s goals, environment, the content, and the brand”, as explained by Cooper in the book

"About Face" (2014, p. 407). There are three principles that color presents, as explained through the Material Design system[20]:

1. **Hierarchical**, where color indicates the level of emphasis of the elements, how they interact with each other and can even indicate the elements that are interactable, or not. Important elements should stand out through the use of color;
2. **Legible**, where there is the need to meet legibility standards when it comes to elements showing in front of the background, for example text and icons. As Cooper explains, on a dark background dark element will appear as faint. But, if the background is light, darker elements will stand out (2014, p. 407);
3. **Expressive**, since color has the power to express the brand's style, it should be used in our favor. Using the brand colors at memorable moments will reinforce the style.

It is best practice to have a limited number of colors composing the palette, otherwise the user will be greeted with the carnival effect. This happens when the color palette is crowded, "overwhelms users and limits (...) the ability to communicate" (Cooper, 2014, p. 408). Likewise, the Material Design system recommends selecting a primary and a secondary color. Then, one can resort to dark and light variants of each. A primary color is the color displayed more frequently across the interface. A secondary color is not mandatory, but is a good way to accent and distinguish the brand. The secondary color should be applied occasionally to accent selected parts of the UI.

Keeping in mind the aspects referred previously, and being aware that the colors need to reflect the brand and style, it was opted for the following color palette (Figure 33):

Figure 33 - Color palette

[20] https://m2.material.io/design/color/the-color-system.html#color-usage-and-palettes

The pink was chosen with the intention of being used in elements that need to stand out in the interface. Pink is the color that is intimately connected with breast cancer, being the pink lace the international symbol for breast cancer awareness (Figure 34). The idea was to continue with the pink, but with a different color value, as a way of creating more contrast with the other two colors (black and white). The white was chosen to be used as the background color and black for the text and small elements that don't have the need to be as prominent as the ones in pink.

Figure 34 - Pink ribbon, international symbol for breast cancer awareness

As a way of ensuring that the contrast between the three colors would work, a Figma plugin was used. Contrast[21], by Maark and Alex Carr, is a tool that allows you to check the contrast ratio of selected colors. When verifying the contrast between the pink and white (Figure 35), one can notice that pink text over white background does not work, and white text over a pink background only works in large text. But, when it comes to graphics, the contrast ratio works. When verifying the contrast between black and white (Figure 36), it is confirmed that pairing these two colors works in every way possible. The last contrast to check was between black and pink (Figure 37). The combination of both colors works almost in every aspect, except for pink text over black background, when focusing on normal text.

[21] https://www.figma.com/community/plugin/748533339900865323/Contrast

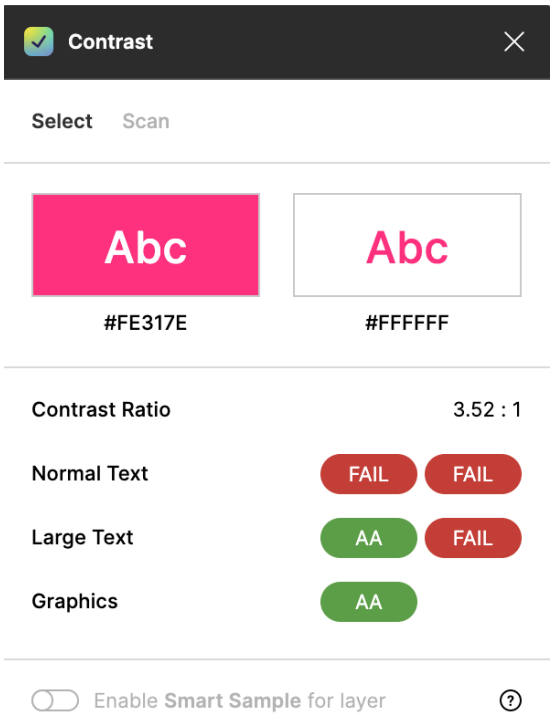


Figure 35 - White and pink contrast

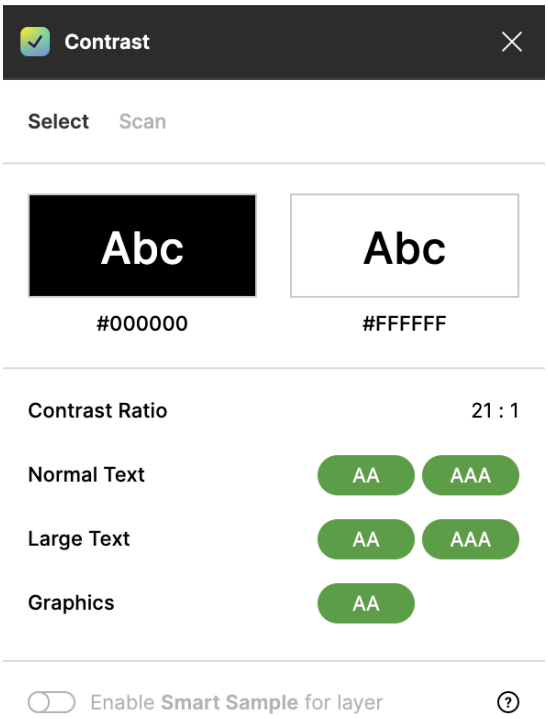


Figure 36 - White and black contrast

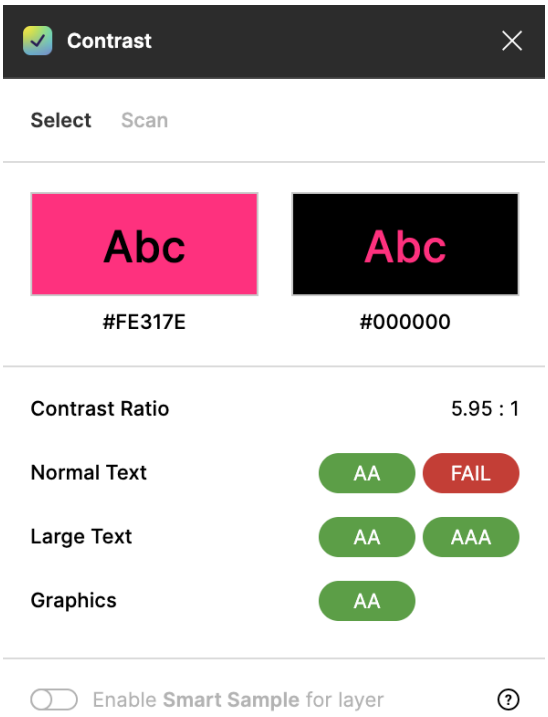


Figure 37 - Pink and black contrast

Logotype

The logotype is of extreme importance, since it visually presents the brand to the users. It is a means of grabbing the users' attention, making a strong and memorable first impression, while creating a distinction from the competition.

For creating the logotype of the proof of concept, it was first necessary to choose a name for the app. A name that represents the brand, has a powerful meaning associated and is distinguishable from the other brands (Cooper, 2014). With this in mind, the name decided for the project was Sakura. Sakura is the cherry-blossom flower and has a strong meaning in Japanese culture. For Japanese, Sakura represents a time of renewal and optimism. But it also reminds the brevity of life, that it can be short and beautiful. In the book "The Cherry Blossom Festival: Sakura Celebration", it is explained that "To the Samurai, the blooming of the cherry trees signified the beauty of a brief life well-lived, its petals falling from the tree in their prime" (McClellan, 2005).

After deciding on the name, it was possible to start working on the logotype (Figure 38). The goal was to have a logotype that is simple, but would stand out. Likewise, it was decided to use typography as a way of creating the logotype. The base for creating the logotype was the main chosen font, previously identified, Roboto Mono. After a few tests that can be found in Annex 7, it was opted to use Roboto Mono Bold and all capital letters, as a way to ensure the readability of the logotype.

S A K U R A

Figure 38 - Final Logotype

A set of rules was created regarding the logotype (Figure 39). In total, 100% of both the height and width corresponds to the space occupied by the logotype. In terms of width, 74% is free space and the remaining 26% of the width is occupied by the letters. There is a margin of 2% at each end of the logotype, which allows to have a safe space for breathability when used with other elements. The space between each character corresponds to 14% of the total width. For the height, 60% corresponds to the space occupied by the character and, the left 40% is for black space. This blank space works, again, as a safe margin for when other elements appear in the interface. Both top and bottom margin have 20% of free space, the safe margin.

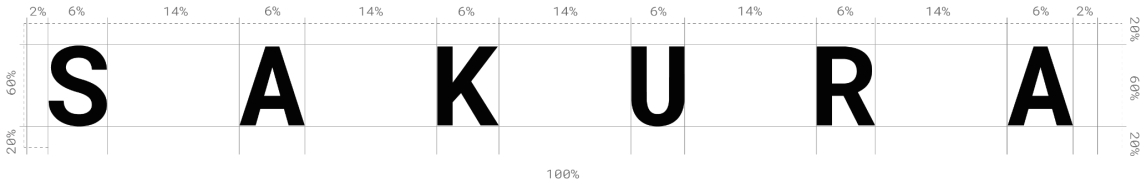


Figure 39 - Logotype rules

As seen in the sub-topic regarding color, the best contrast is created with black over white. This combination works in every parameter, from text to elements and, since the background of the interface is intended to be white, it is the best option for the logotype to be black. This will assure that the contrast will have an appropriate ratio, either with white or pink background.

Layout and grid

“A grid system is one of the most powerful tools available to the visual designer”, as stated by Alan Cooper (2014, p. 415). Having a grid system provides a uniform and consistent structure to the interface layout, helping to establish the visual hierarchy created, emphasizing “top-level elements and structures” (Cooper, 2014, p. 415).

Although it is recommended for a grid to follow an idealized geometric relationship, the grid should be flexible enough to deal with essential variations of the grid, whilst maintaining the consistency since “slight differences can feel unstable to the users” (Cooper, 2014, p. 417). Having a defined grid has the following benefits, according to Cooper (2014, p. 417):

- **Usability**, since grids attempt to regularize positioning of elements. This consistency supports the users’ “innate visual-processing mechanisms”;
- **Aesthetic appeal**, creating a sense of order that it is comfortable to look at;

- **Efficiency**, by standardizing the created layouts. This allows the design to be modified and extended easily.

Another important aspect to take into consideration when creating a grid, is to offer a logical path. For example, in western societies the eyes move from top to bottom, left to right. This allows users to read the layout in an efficient and effective way (Cooper, 2014, p. 418).

For creating a grid it is necessary, according to Material Design, columns, gutters and margins. Figure 40 presents the constructed grid, with the necessary elements. There are three columns, equally divided through the layout, where the content was placed. Although not talked about in Material Design, having rows is also important for constructing a grid layout, allowing for a correct partition of the horizontal space. In total, the grid counts with 6 rows. Between each column and row there is a gutter, the free space that helps separate the content. To finish the grid, a margin was created on both sides, making sure that the content does not get too close to the limits and having enough breathable space for the elements.

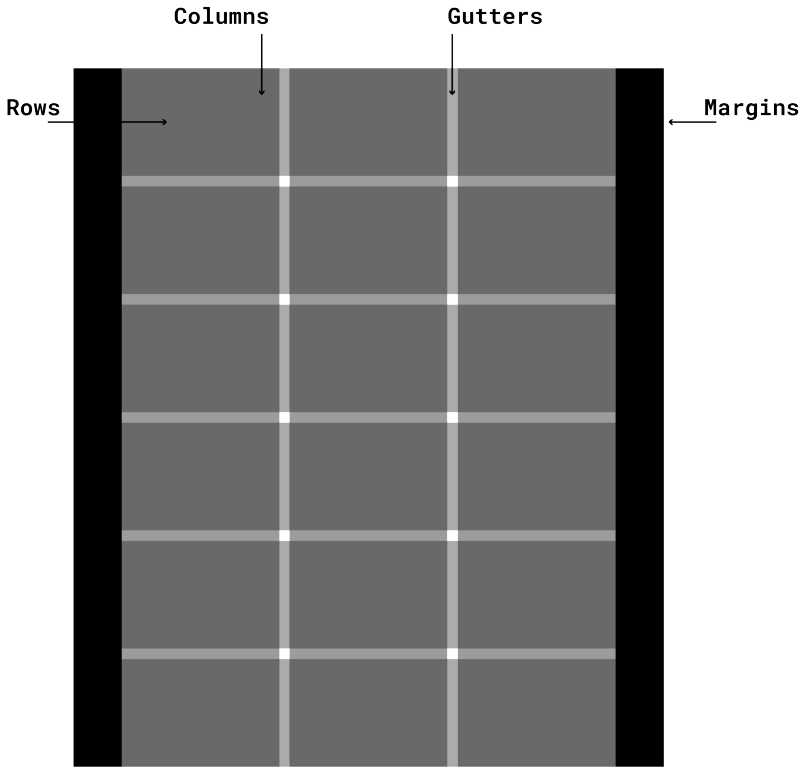


Figure 40 - Grid

Iconography

As a way of visually communicating a determined function and behavior, icons are crucial. Icons need to be consistent, having the power to hold the visual style together. When resorting to icons to visually represent something, the following guidelines should be taken into consideration (Cooper, 2014, p. 419):

- **Represent** the **action** and an **object**, simultaneously, as a way of improving comprehension;
- Be **aware of metaphors and other meanings** that are not the same for our target audience;
- **Related functions** should be **linked** in order to provide more context;
- Resort to **simple icons**, avoiding excessive visual detail. Simple and schematic colors, minimizing the number of colors and shades used;
- **Reuse icons** whenever possible. This ensures that users do not have the need to apprehend their meaning only once.

Based on the previously described guidelines, the icons intended for the app user interface were created (Figure 41). These icons are simple, with geometric lines, bold, graphic and with consisted lines, and reduced to their minimal form, expressing the essential message. The icons present a symmetrical and consistent look, helping with readability and clarity and were used for the navigation, the menu, and to represent different sections of the interface, having each icon a specific meaning.

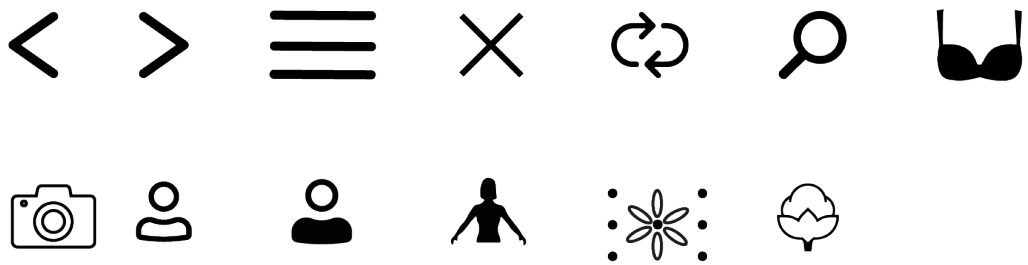


Figure 41 - Icons

The buttons created for interacting with the proof of concept are, again, very simple and geometrical, being the main goal to explain their function. Figure 42 presents the normal state of the button and after the interaction occurs. Some buttons were paired with an icon (Figure 43), an arrow, as a way of creating distinction from other buttons and representing dropdown menus.

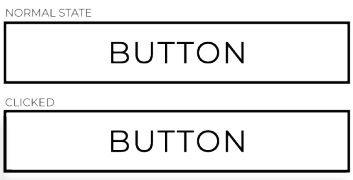


Figure 42 - Buttons

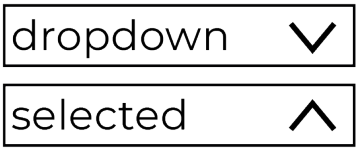


Figure 43 - Buttons dropdown menu

For the buttons that represent the colors that the user can choose for the personalization of the bra (Figure 44), it was opted for using a circle, since it is distinguishable from other buttons. As a way of making the proof of concept more accessible, the buttons of each color also have the first letter of the word they are representing. This was mainly thought for people who are color blind. When a color is selected, the button has a black outline as a form of indicating the chosen color.

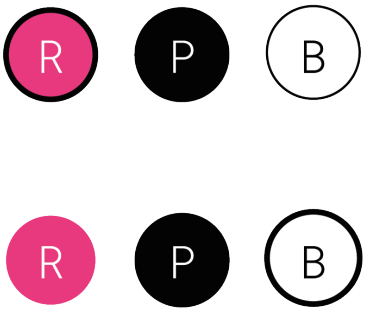


Figure 44 - Buttons colors

5.3. Chapter summary

This chapter presented the visual identity and 3D modeling created for the proof of concept. As stated in the beginning of this chapter, both these activities were carried out individually. Nonetheless, it was necessary to take into consideration the participants' input when it came to create the bra model.

The presented sketches of the bra resulted into a 3D model that contemplated the needs and desires shared by the women who participated in the set of planned activities. The created visual identity, that resulted in a style guide, was used in the interface of the proof of concept as a way of ensuring a consistent identity. In the next chapter, one can find the prototypes that were created and that rely on the presented style guide.

6. User interface design and evaluation

This chapter describes the iterative design process of the user interfaces prototypes and their evaluation. The participation of end-users was only requested for the evaluation of the prototypes. In this chapter, one can find the process behind the creation of evolving fidelity prototypes, ranging from low to high-fidelity. Then, the conducted usability tests and results are presented and analyzed.

For designing the user interface, it was considered previously obtained knowledge such as:

- the Donald Norman Design Principles, presented by Donald Norman;
- the assembled 3D model of the bra, that contemplates the women's' needs and desires;
- the created visual identity, that culminated in a style guide intended to be used in this process;

6.1. App flow

Before starting to work on the creation of the prototypes, it was necessary to understand how the proof of concept would work, making it necessary to think of the app flow (Figure 45 and Figure 46). This is an important step before starting to visually think of the user interfaces, since it allows one to truly understand what screens are necessary to prototype.

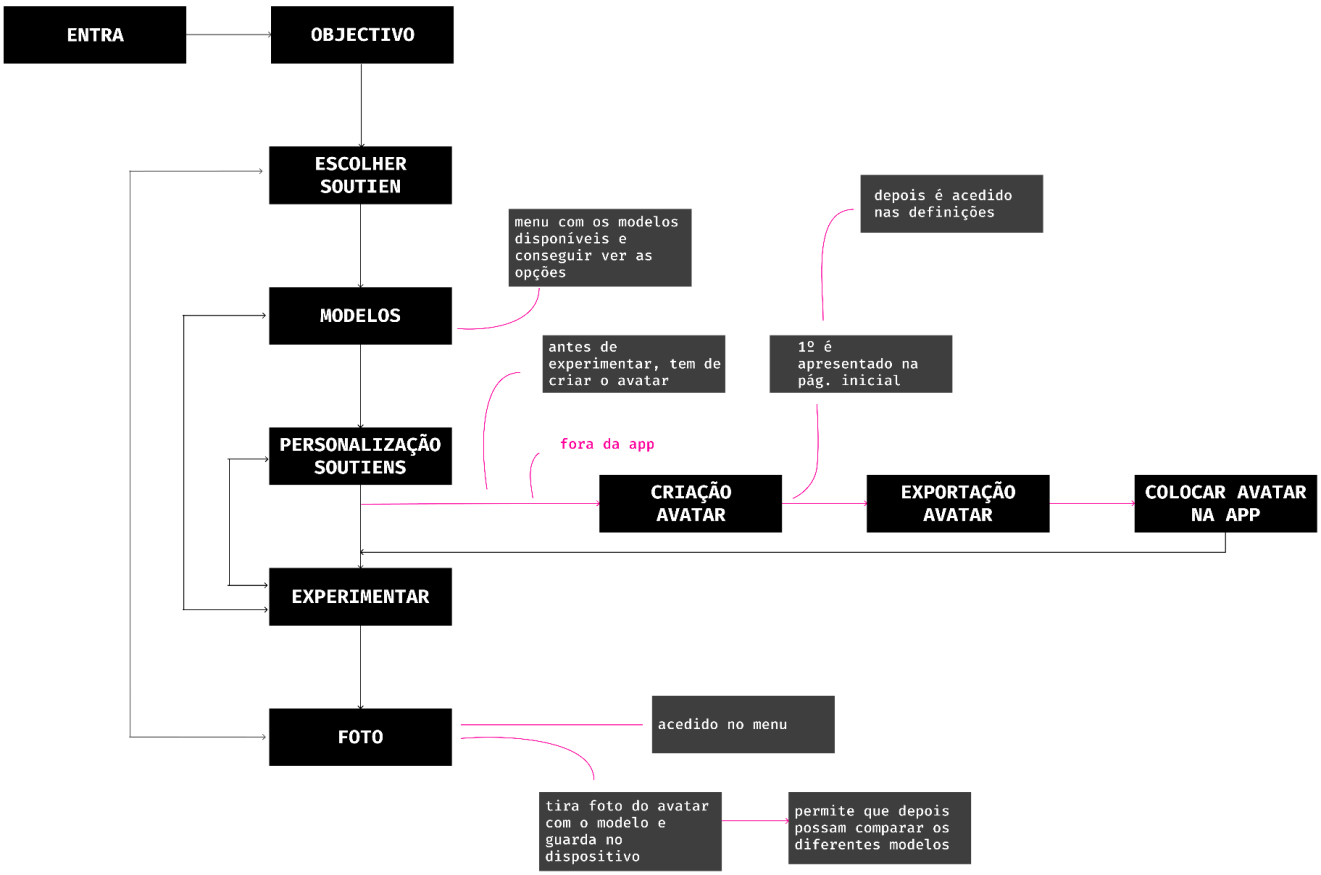


Figure 45 - App flow

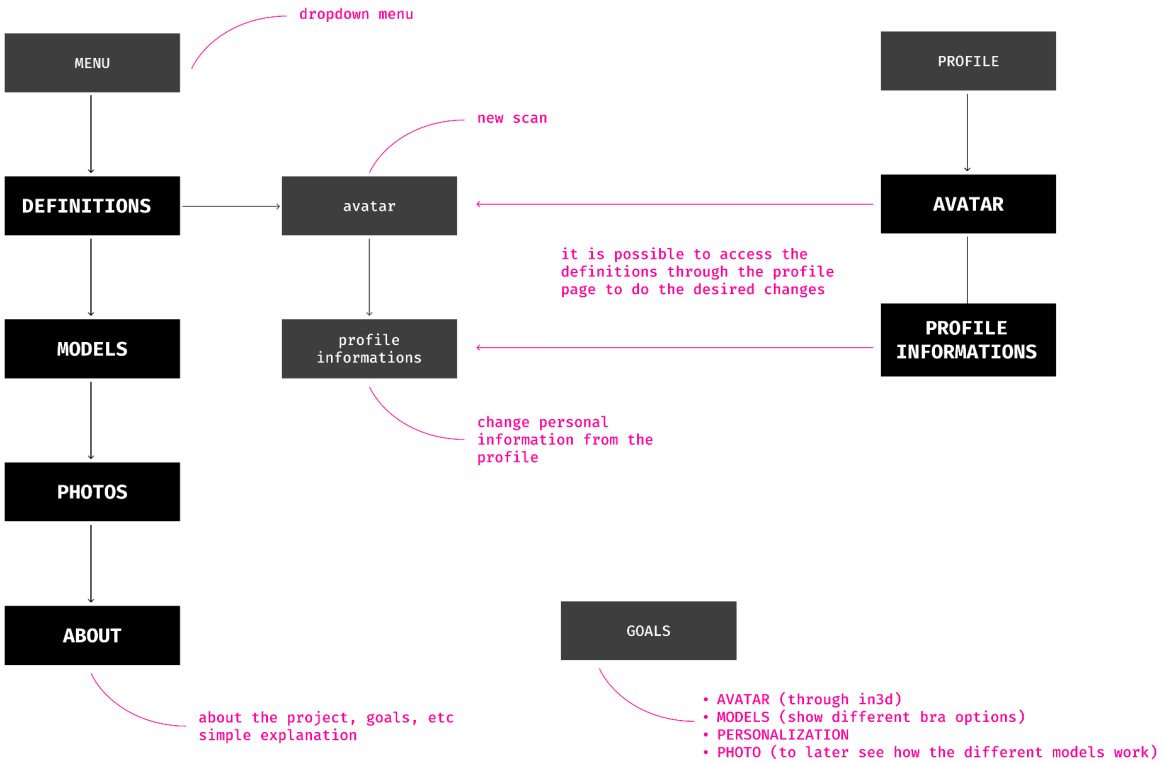


Figure 46 - App flow for the menu

The three evolving fidelity prototypes were created, starting from paper prototypes and finishing with the unity prototypes. After concluding the medium-fidelity prototypes, usability tests were conducted as a way of understanding if the prototypes were meeting the users needs. With the medium-fidelity prototypes finished, it was possible to move to the high-fidelity prototypes, and make the necessary changes based on the results from the usability tests. Since the conducted tests did not present any major errors, it was decided to not perform any more usability tests. In the following sections, this process is described and the results are presented and analyzed.

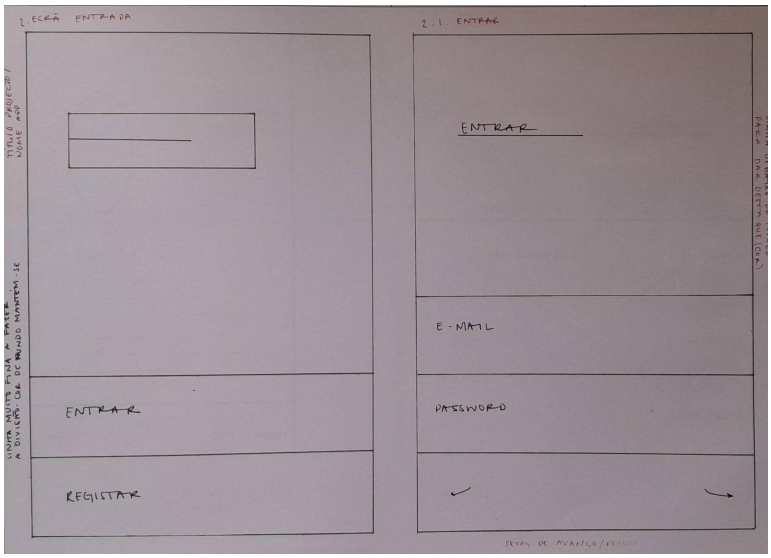
6.2. Increasing fidelity prototypes

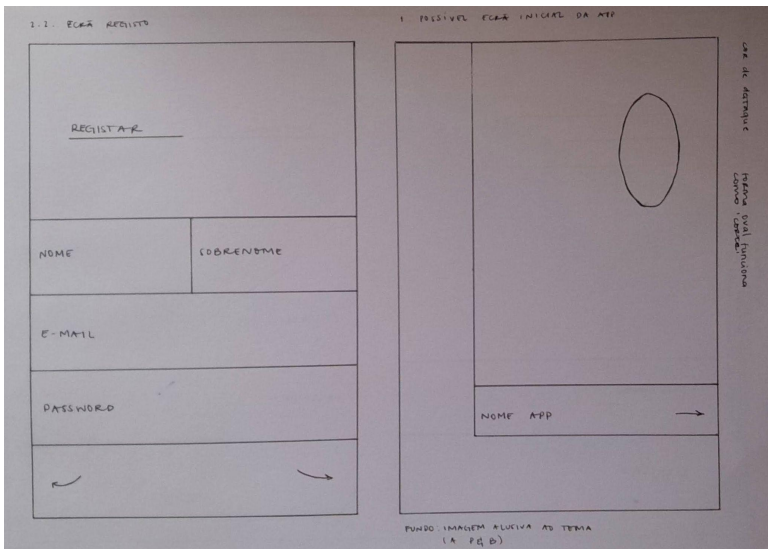
As stated in the research stage, prototyping is a crucial step when designing a proof of concept, helping to transform the collected information into visual representations. In this stage of the project, evolving fidelity prototypes will be created, following three different phases:

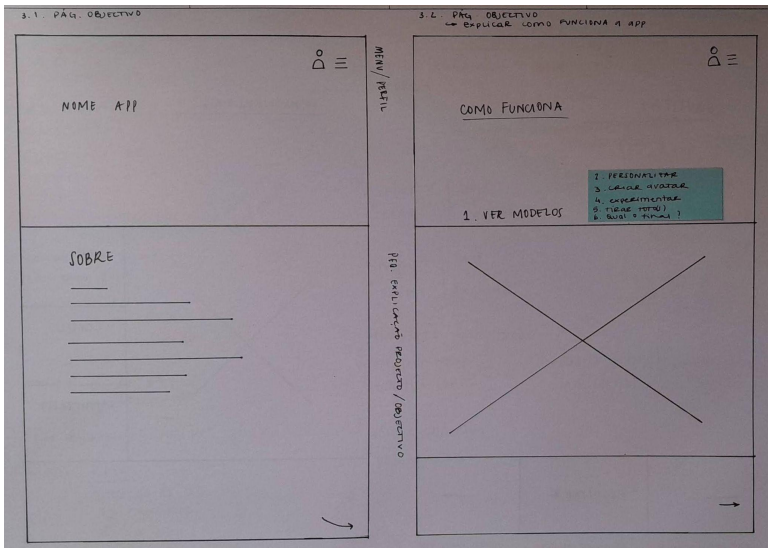
1. **Low fidelity** prototypes;
2. **Medium fidelity** prototypes;
3. **High fidelity** prototypes.

Low-fidelity prototype

The first step to start to visually understand the emerging ideas, was to develop low-fidelity prototypes that took form in paper prototypes. In these paper prototypes, the user interface layouts were thought out, following a solo process. In this stage, there was no external input from the participants of the previously described activities. In annex 8, one can find other paper prototypes created that were on the base for the final prototypes were presented (Figure 47).


1. ECRÃ ENTRADA
2.1. ENTRAR
ENTRAR
E-MAIL
PASSWORD
ENTRAR
REGISTAR


2.2. ECRÃ REGISTO
1. POSSIVEL ECRÃ INICIAL DA APP
REGISTAR
NOME
SOBRENOME
E-MAIL
PASSWORD
NOME APP
FUNDO IMAGEM ALUSIVA AO TEMA


3.1. PÁG. OBJECTIVO
3.2. PÁG OBJECTIVO
↳ EXPLICAR COMO FUNCIONA A APP
NOME APP
MENU/PERFIL
COMO FUNCIONA
1. VER MODELOS
SOBRE
PÁG. EXPLICAÇÃO PROJETO/OBJECTIVO

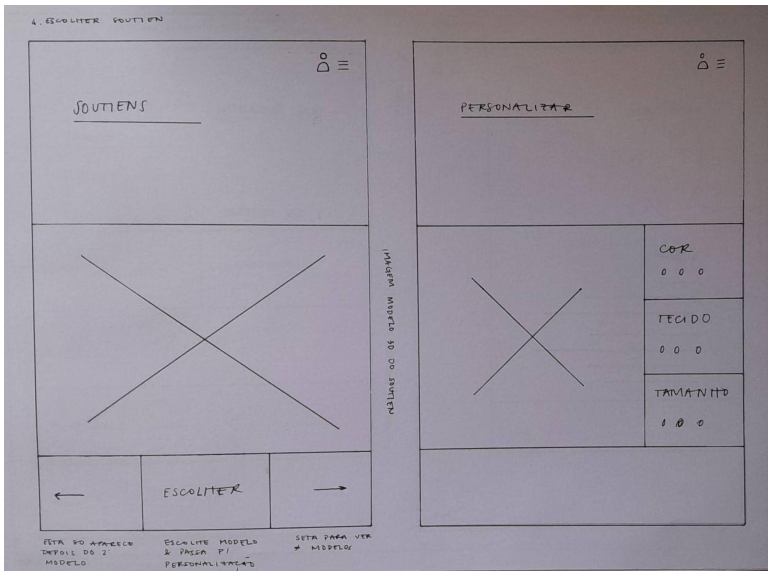


Figure 47 - Final low-fidelity prototypes for the layouts

This was a part of the process that allowed to put into practice all the acquired knowledge obtained during the academic years, regarding UI/UX design. The present low-fidelity prototypes are not imperative, since sometimes the prototypes work in paper, but not in digital format.

Medium-fidelity prototype

The medium-fidelity prototypes followed what was decided in the first phase of prototyping, and turned the paper versions into a digital version. For creating the medium-fidelity prototypes of the user interface, the chosen software was Figma[22]. The prototypes were created based on the style guide, presented in section 5.2, as well as the literature review and Norman's Design Principles. In the following section, the layouts created in the medium-fidelity prototyping phase will be presented, and the different versions they went through until the finish. The rest of the layouts can be found in the Annex 9.

Entrance layout

The entrance layout of the proof of concept suffered some alterations (Figure 48) before achieving the final layout (Figure 49). The low-fidelity prototypes contemplated the usage of an image for the first layout, as a way of helping to visually understand the topic that it is connected with the proof of concept. But, after seeing how the colors and the typography work together, we concluded that the layout was too crowded and created some visual confusion, especially with the bright pink rectangle that occupied almost all of the screen. A simpler layout was considered and ended up discarding the image and turning the pink in a more subtle object, through a blur effect (Figure 49).

[22] https://www.figma.com/file/vhUxzhWxkX0G6DddogB35n/prototypes?node-id=0%3A1&t=wbTQb1TN4FhfPgYi-1

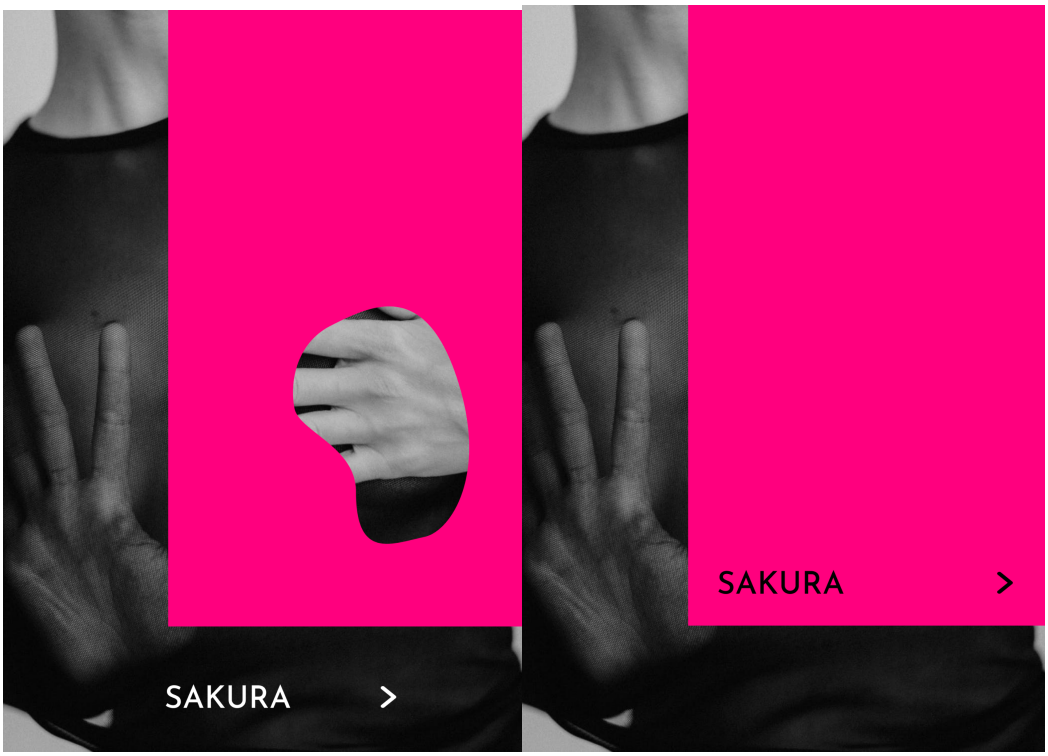


Figure 48 - First propositions for the entrance layout

Figure 49 - Final entrance layout

Login layout

For the login layout, it was first tried to have a decorative element on the screen. In this case a Sakura flower (Figure 50). But the illustration style was not working with the intended

visual style, with minimalist and clean lines. So, it was decided to abandon the idea of having an illustration with the pure purpose of decoration, in any of the layouts.

Figure 50 - First propositions for the login layout

At the end of creating all the layouts for this stage of the work process, this layout was redesigned and added a new subsection, the about section (Figure 51). It made sense to have the possibility to learn more about the proof of concept before having to create an account.

Figure 51 - Final login layout

Personalization layout

This was the layout that took the most effort in this phase. In the first versions (Figure 52), all the information regarding the bra model and the personalization was on the right side of the screen, creating some visual instability.

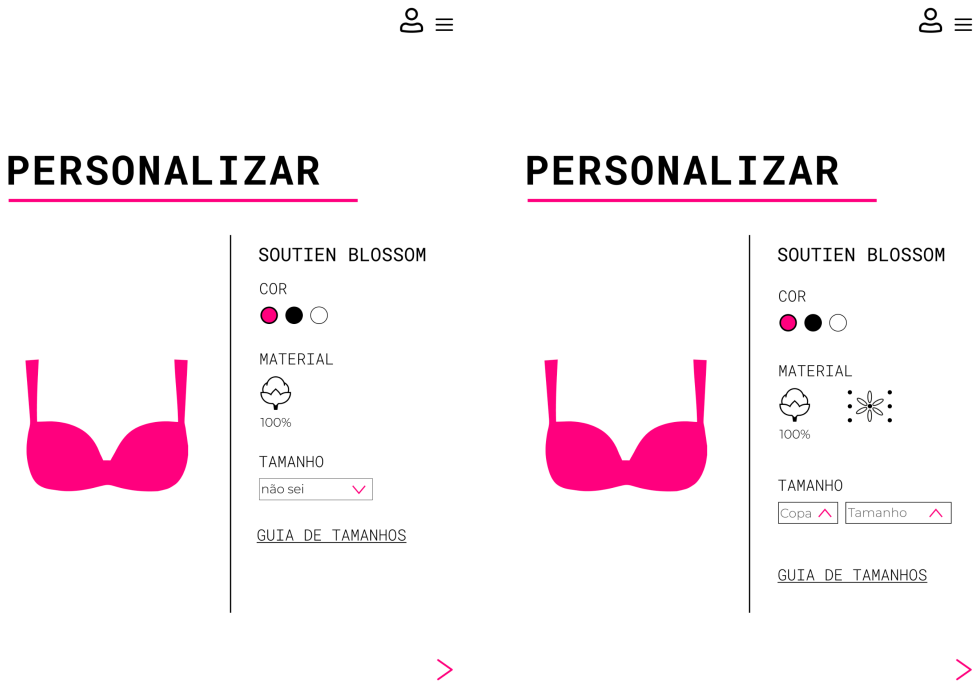


Figure 52 - First propositions for the personalization layout

Furthermore, there was the need to add two more functionalities in this section (Figure 53). The first was the possibility for the user to take their own measures using a sensor, the intel one. Although we already knew that this part of the project was not possible to implement, since this is a proof of concept, it made only sense to continue to include the part of resorting to a sensor to take the specific measures of the user. After adding this functionality, it was concluded that it also made sense for the users to be able to see the previous measures, not being necessary to go through the whole measuring process.

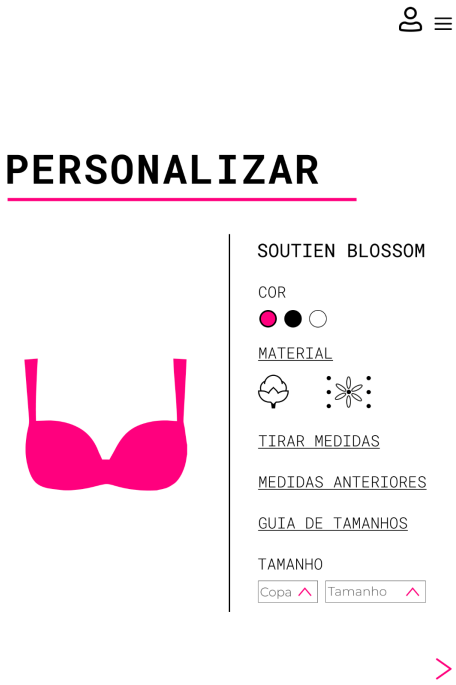


Figure 53 - Second proposition for the personalization layout

The final personalization layout (Figure 54) presents some differences. First, the problem of the visual instability was overcome by shifting some information to the left side and rearranging the placement of the elements. The 3D model of the bra is also contemplated in this layout.

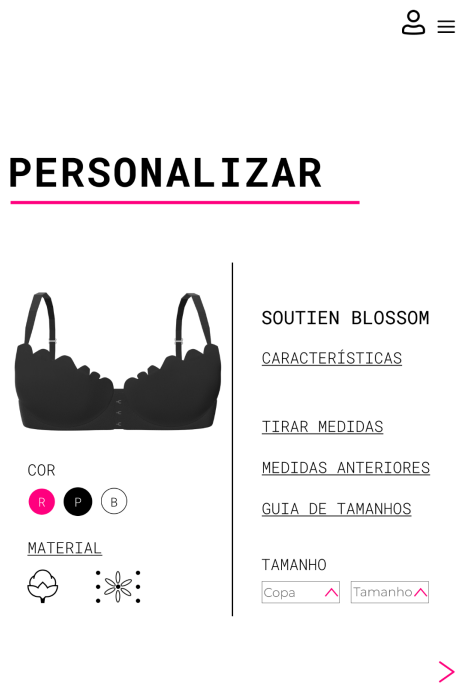
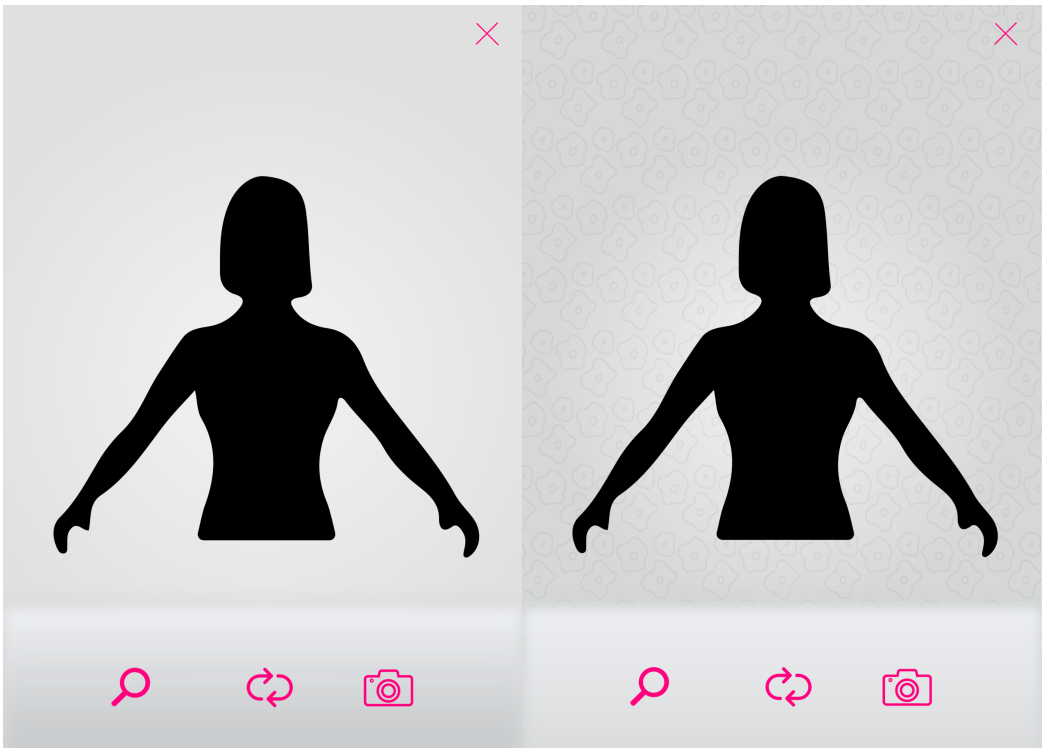


Figure 54 - Final personalization layout

Virtual dressing room layout

This screen was a challenge to prototype, since it was desired to convey the idea of the user being in a dressing room, but it could not be something hyper realist, that would clash with the style chosen for the proof of concept, with simple illustrations and geometric lines. The initial proposals (Figure 55) tried to mimic a 3D effect of a simple wall, and even experimented with some patterns to create a more depth effect. Still, after the different options, the layouts were not producing the desired effects.



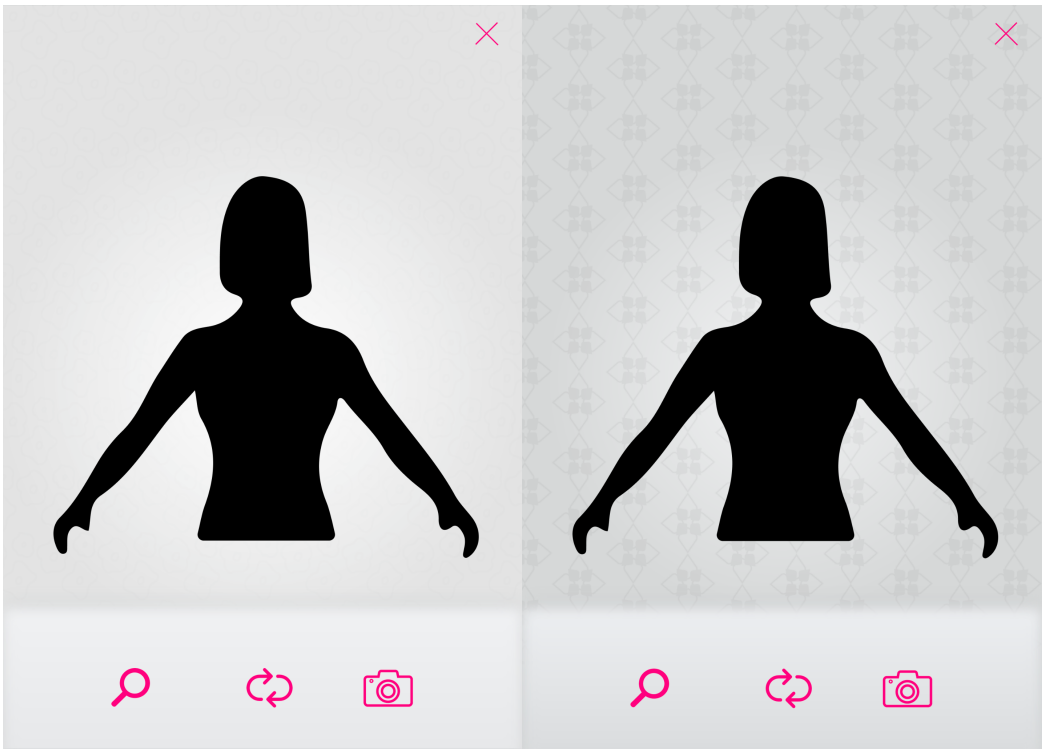


Figure 55 - First propositions for the personalization layout

We then tried a new approach for the final screen, trying to incorporate the illustration style once again (Figure 56). Resorting to cherry blossoms, we designed a simple illustration to use as background and abandoned the idea of having something similar to a dressing room as background. With this illustration, the visual harmony we were trying to obtain was achieved between all elements.

Figure 56 - Final virtual dressing room layout

High-fidelity prototype

The last set of prototypes to be created were the high-fidelity[23] ones, which were created using Unity as the development tool. These high-fidelity prototypes represent with great detail how the final product could be, when implemented. There was a need to study some aspects regarding Unity, in particular the used language C#, resorting to online libraries and forums, such as Stack OverFlow[24] and the Unity Forum[25].

It was in this stage that the 3D avatar was created, using the in3d[26] app. This is a fairly simple app to use, only needing to follow the instructions on the screen. Through a series of photographs of the user, making a 360º turn, the app is able to create a reliable 3D model of the body, even with the textures of the clothes the user is wearing (Figure 57).

Figure 57 - 3D avatar created with in3d

After creating the 3D model, using in3d[27], and seeing how the model with the textures functioned with the background chosen for the screen, it was evident that it did not work visually. As a way of overcoming this, it was decided to use the pink, present in the style guide, as texture for the 3D model (Figure 58).

[23] https://youtu.be/ly9-KhvlTaU
[24] https://stackoverflow.com/
[25] https://forum.unity.com/
[26] https://in3d.io/
[27] https://in3d.io/

Figure 58 - Final 3D avatar

With all the elements created, it was possible to move to the development of the high-fidelity prototypes, using Unity. As stated previously, the user interface layouts are the same as the ones created in the medium-fidelity prototypes. The presented user interface layouts have the same measurements as the tablet used for this project (1600 px x 2560 px). It was chosen to use a tablet as a midst of presenting the project to the user because it supports the app in3d, used to create the 3D avatars; it is something that it is portable, being easy to transport; and offers a good screen size to display the necessary information, helping with readability.

Nonetheless, some difficulties were encountered in this part of the project. Although the majority of the functionalities were prototyped, there were a few that ended up not being completed. In the virtual dressing room (Figure 59), it was not possible to have both the desired background, contemplated in the medium-fidelity prototypes, and the 3D elements (avatar and bra). It was then decided to keep the background white (Figure 59)like in the rest of the proof of concept, as a way of keeping the 3D elements created.

Figure 59 - Final dressing room screen

For zooming in the 3D objects and having the possibility to rotate the same objects in 360º, there was a need to have a C# script that could control these movements. Although some attempts were made, and having thoroughly researched possible solutions, the results obtained were not the desired ones. Since the prototype did not offer the possibility to take a photo of the 3D avatar with the chosen bra (Figure 59), it was not possible to conclude the gallery screen (Figure 60). Although the previously described functionalities were not implemented completely in the high-fidelity prototypes, they were still considered. Further discussion was carried out in chapter 7, dwelling on the strengths and caveats of the project, as well as future work.

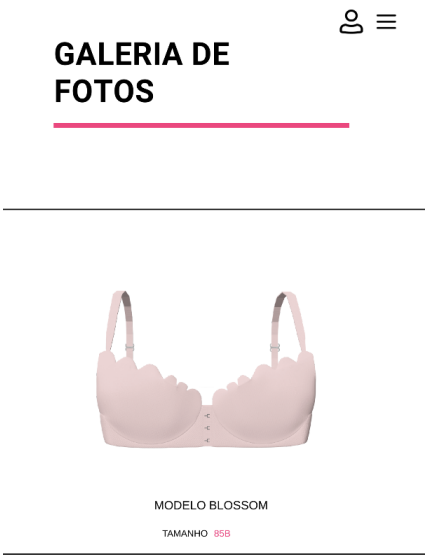


Figure 60 - Final gallery screen

The other functionality that does not present its complete final form is the direct connection between the proof of concept and in3d. In3d is the app that allows users to create a 3D avatar, accurate to their bodies. Ideally, the link between the proof of concept and in3d would be smooth, without having the need to exit the proof of concept, go to in3d and then back to the proof of concept. Many attempts were made in order to overcome this obstacle, but without success. The truth is, it is still possible to create the 3D avatar and then import it to the proof of concept, so the goal for this functionality is still being fulfilled, although not in its most optimized way. Nonetheless, the functionalities continue to be contemplated in the layouts. Also, these functionalities are considered extras in the proof of concept, meaning that the project continues to achieve the main goal that was intended from the beginning - the personalization of a bra for women who have undergone mastectomy. In the following section, the conducted usability tests are presented, as well as the results.

6.3. Usability tests

The following section presents the evaluation of the medium-fidelity prototypes. Carrying out a usability test is an effective way to understand how the users interact with the prototype, offering the necessary information to understand if the "assumptions about how people will understand and use the design as they are hold true" (Kuniavsky et al., 2012, p. 344). Next, the procedures followed and results are described and analyzed.

Goals

Usability testing can help "to determine how well a design allows users to accomplish their tasks" (Cooper, 2014, p. 140). We then carried out an evaluation to gauge the effectiveness of the prototypes and smooth over some rough edges. This evaluation was meant to understand if the developed medium-fidelity prototypes were following the right path, allowing the user to correctly interact with them.

Participants

Although it made sense to continue to work with the same number and, ideally, the same participants, as in the previous phases, after a few attempts of contacting and arranging a meeting to conduct the test, it was not possible to carry out the test with two of the four women who previously participated in the study. Nonetheless, and resorting once again to personal contacts, it was possible to recruit two more women who have undergone mastectomy, and have a total of four women to participate in the tests.

Besides this previously described group, it was also decided to recruit four more women that did not battle breast cancer. It was a way of understanding if the user interface was correctly designed, since it would be presented to women outside of the niche the project was created for. It was also a way to test the idea of the project, personalizing and virtually trying on bras, regardless of having undergone a mastectomy or not. The final number of recruited participants for the usability tests was eight, four of each group. The following section offers an overview of the followed procedure.

Procedures

At the same time the participants were being recruited, the script for the evaluation was being prepared. The script, that can be found in Annex 11, is divided in three different sections: informed consent; initial survey with sociodemographic profile questions; and a set of previously defined tasks for the participants to carry out while using the app. The tests were recorded, as a way of helping in the analysis. The tests were in person, since it was necessary

to hand to the participants the tablet with the prototypes and see how they interacted with the prototype.

Participants were asked to verbally express their thoughts while interacting with the prototypes. This method is known as think aloud and, as explained by Nielsen, "in a think aloud test, you ask the participants to use the system while continuously thinking out loud - that is, simply verbalizing their thoughts as they move through the user interface" (2012). This method allows us to understand the thoughts the participants have when interacting with the prototypes. For example, when the participant encounters one difficulty, verbalizing not only helps the researcher to understand what is making the user unable to carry the task, but talking can help to unlock any difficulties.

When starting the test, after the informed consent was read and signed, the participants were asked a set of questions in order to understand the sociodemographic group we were working with. The majority of the participants, 5 out of 8, were in the range of 56 to 65 years. Only one woman was below 50 years old and the other one was over 66. Half of the participants, 4 out of 8, had retrieved their own measurements when acquiring a bra, the same number of women who have bought something online. On a daily basis, only 3 women use a tablet, either for leisure or work. Of these 8 participants, 4 had undergone mastectomy and have bought bras for post mastectomy.

After this questionnaire was completed, it was asked for the participants to explore the prototype, freely, for about one to two minutes. After this initial exploration, participants were given seven tasks to complete, as a way of guiding the user through the test, but not giving any clues throughout the test. After the test was completed, a set of open answer questions was presented, regarding the prototypes and specific functionalities it offered. In the end, two different questionnaires were made. The first one, System Usability Scale[28] that consists of ten questions, with five response options, ranging from "strongly disagree" to "strongly agree". The second questionnaire was the Net Promoter Scale, which gauges the probability of users to recommend the system at stake.

Tasks

As stated in the previous point, the participants were given seven tasks to complete in the usability tests. These tasks were representative of the different functionalities the prototype offered. The tasks followed the natural flow of the proof of concept, making the navigation through the tasks more natural and easily understandable.

[28] https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html

Task one: See the explanation of the proof of concept
It is the first time the user is opening the app Sakura and does not know how it works, just knows that it will help to try, virtually and at home, bras that were designed based on specific needs and desires. Thus, the first task is to learn about the app and understand how it works.

Task two: Register on app
Now that the participant understands the got a feel of how the app works, the user is asked to create an account to start using the app.

Task three: Choose a bra
After logging in the app, the user is asked to browse through the available models and choose one to personalize.

Task 4: Personalize the chosen bra and take measurements
The step after choosing a bra model, is to personalize it. The user is asked to take measurements of the bust, no matter the way the user chooses to follow, still the goal is for the user to find the ideal bra size. After that, the user is asked to explore the different options regarding aesthetic personalization, such as color and fabric. Since this function is very particular to this proof of concept, three questions are asked, regarding this task:

- Do you find this functionality relevant?
- Is there anything you did not understand?
- Do you have any improvement suggestions?

These same three questions are also asked in the following tasks.

Task 5: Create avatar
For virtually trying the personalized bra, the user needs to create a 3D avatar. In this task, the user is asked for the participant to create this 3D model, resorting to the app in3d.

Task 6: Virtual dressing room
After choosing and personalizing the desired bra, and having created the avatar, the user is asked to go into the virtual dressing room and try on the bra. The user is also asked to take a photo of the avatar with the bra.

Task 7: Go to the photo gallery
After taking the photo in the virtual dressing room, the participant is asked to go to the photo gallery and see how the bra looks on the avatar, based on the previously taken photo.

The results of these usability tests are presented, and analyzed, in the following section of the document.

6.4. Results and key insights

In the usability tests we collected the following metrics:

- **Time** it took to complete the task;
- **Taps** on the screen to completing the task;
- **Errors** made before completing the task;
- Task **completion** (or not);

To analyze the results, the recordings of the tests were watched and the previously presented metrics were collected into a spreadsheet. For a better understanding, the analysis of the results was divided into the two different groups of participants: women who have undergone mastectomy; and women who never battled breast cancer. It made only sense to distinguish these two groups as a way of first understanding if the prototypes were meeting the needs and desires of the niche group the project is being developed for, so women who have undergone mastectomy, but also see the possibility to broaden the possible end users group to women in general.

The first results to be analyzed were the sociodemographic profile of each participant and, afterwards, create a set of graphics that allowed an overview of the group of the eight participants. The majority of the participants were in the same age gap (Figure 61), between 56 and 65 years old.

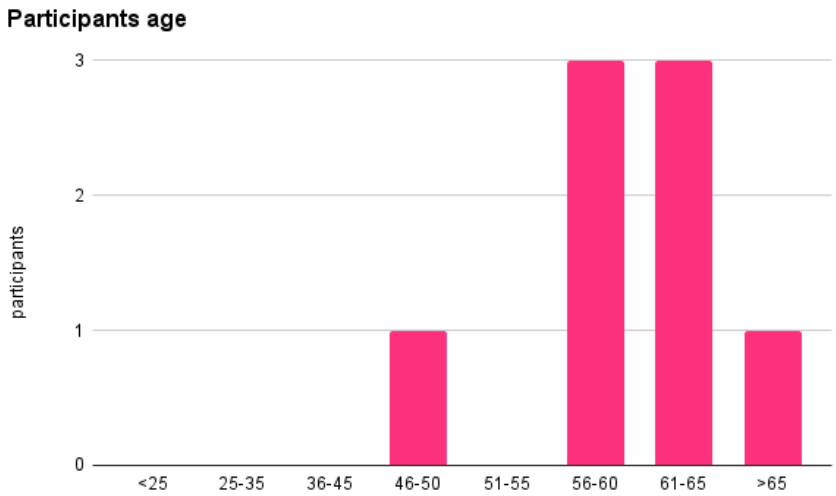


Figure 61 - Participants age

When it comes to buying bras for post mastectomy, four out of the eight participants have bought these specific bras, since there are four participants who have undergone the procedure. Women were also enquired about having taken their own measurements when needed to acquire a bra. Once again, four out of eight participants have done it (Figure 62).

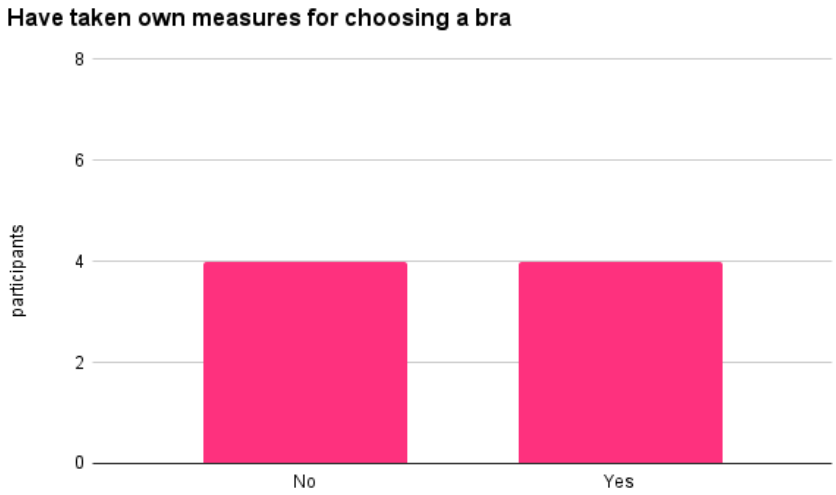


Figure 62 - Participants who have taken their own measures

The last two questions of this section of the test, focused on the experience of shopping online and the usage of a tablet. When asked if they ever shopped online, half of the participants answered affirmatively (Figure 63). The same did not happen when questioned about using the tablet on a daily basis (Figure 64). Only three of the participants use a tablet daily, two of them for leisure and one for leisure and work.

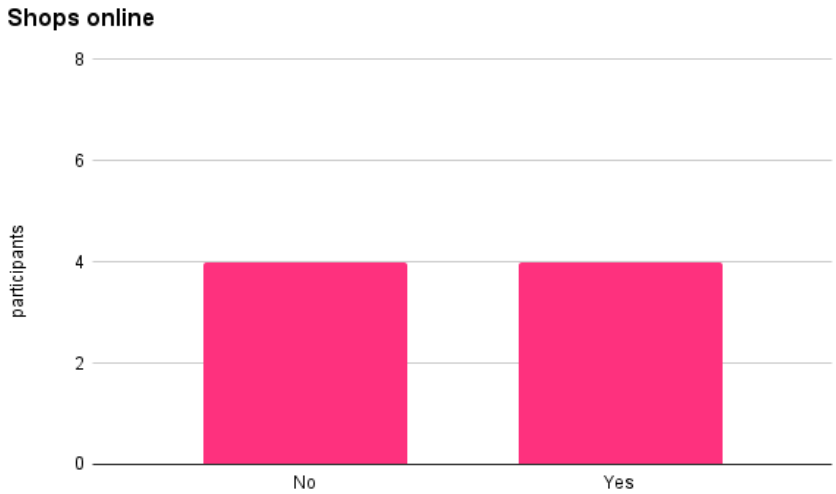


Figure 63 - Participants who shop online

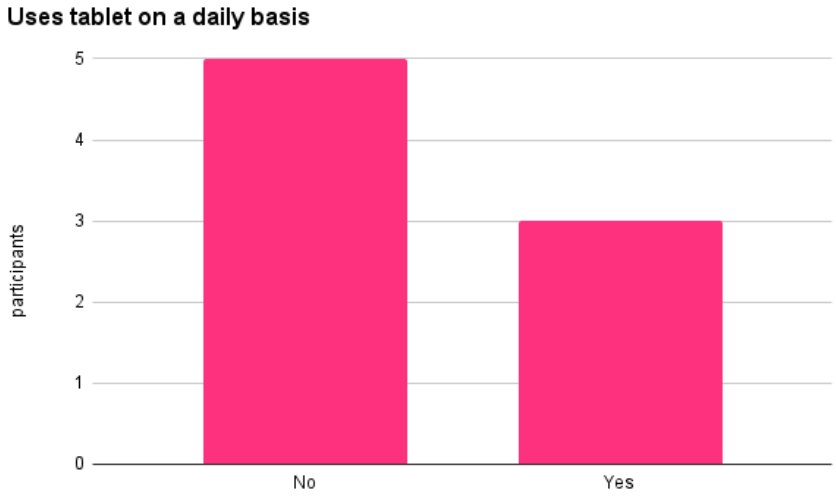


Figure 64 - Participants who use tablets on a daily basis

The next paragraphs report on the results of the usability tests. Here, the results were analyzed based on the previously presented parameters: time, touches, errors and task completion. The results were also divided according to the two different groups of participants. Before moving to the analysis of each parameter, it is important to note that all seven tasks were completed successfully by all eight participants.

For a better organization of the results, group 1 (in pink) represents the group of participants who have undergone mastectomy and group 2 (in gray) refers to participants who have not. In terms of average time, the second group took less time to complete a task than group 1, ten over sixteen seconds (Figure 65). Looking over group one, task four was the one that took longer to complete. The same happened in group 2, and this is easily understandable since task four was the one that involves more steps in order to be completed.

Group 1 - Time on task	
task 1	0:01:22
task 2	00:00:16
task 3	00:00:03
task 4	00:01:49
task 5	00:00:28
task 6	00:00:09
task 7	00:00:14
total	**0:00:16**

Group 2 - Time on task	
task 1	0:01:16
task 2	0:00:10
task 3	0:00:03
task 4	0:01:38
task 5	0:00:17
task 6	0:00:07
task 7	0:00:08
total	**0:00:10**

Figure 65 - Average time taken to complete a task

When it comes to the average number of touches (Figure 66), group one needed a higher number of touches to complete the task when compared with group 2. Although group 1 presented a higher average number of taps on screen, group 1 displayed a huge difference in task number one, where group 2 needed to perform a considerably higher number of taps to complete the task. When thinking about the task and remembering the tests, this happened

because some of the participants had difficulties understanding that for entering the app they needed to click on a button instead of swapping on the screen, as they were used to. This is also confirmed by the average number of errors each group presents in task one (Figure 67). Nonetheless, all participants were able to independently conclude the task. Once again, task four was the one that presented a higher average number of taps, in both groups, due to the complex nature associated with the task.

Group 1 - Touches on screen	
task 1	7,5
task 2	4,5
task 3	1
task 4	23,5
task 5	5
task 6	2
task 7	3
total	3,75

Group 2 - Touches on screen	
task 1	10,5
task 2	3
task 3	1
task 4	21
task 5	4
task 6	2
task 7	3,5
total	3,5

Figure 66 - Average number of touches to complete a task

Group 1 - Errors per task	
task 1	0,5
task 2	0
task 3	1
task 4	0
task 5	0
task 6	0
task 7	0
total	0

Group 2 - Errors per task	
task 1	0,5
task 2	0
task 3	0
task 4	0
task 5	0
task 6	0
task 7	0
total	0

Figure 67 - Average number of errors

The usability test also contemplated a set of questions that the participants were asked to respond to. Mainly, these questions were about the prototypes and what the participants thought about the same, in which participants were invited to share their impressions and propose improvements. Both groups of participants shared that they think that the concept presented through this project is an interesting one, confirming the difficulties behind finding bra options that are elegant and functional for post mastectomy. The participants also shared the feeling they had towards the prototypes and the design of the same, being something "subtle and discreet. The information is objective and goes straight to the point". Participants also shared that the app flow is very natural and easy to navigate across screens.

These questions were also a good way to understand the possible downsides the participants noted towards the prototypes. One of the women shared that, in the beginning of the usability tests, she found the way to go back between screens of the prototypes was a bit confusing, but soon after she was able to understand how it worked. Another participant highlighted that the background of the virtual dressing room did not work well when compared with the remaining design of the layouts.

Regarding the presented 3D model of the bra, it was asked directly to the participants to share their thoughts about the model. The results were that all the participants shared the opinion that it was an elegant and practical option. Nonetheless, they wished they had some more options to choose from. So, this is something that should be taken into consideration in future work to be developed and presented in the next chapter.

To end the usability tests, the participants were asked to fill a system usability scale (SUS) questionnaire and a net promoter score (NPS) question, as well. The system usability scale allowed us to understand how the personal experience of the users was towards the proof of concept, being asked to classify a set of ten questions from 1 to 5, being 1 “totally disagree” and 5 “totally agree”. For analyzing the System Usability Scale, it is suggested to resort to the following interpretation (Tullis & Albert, 2013, p. 139):

- <50%: not acceptable;
- 50-70%: marginal;
- >70% acceptable.

To answer the net promoter score, the participant is asked to answer, on a scale of 0 to 10, whether he/she would recommend the platform to another person. For interpreting the results, we also resorted to one interpretation presented by Tullis & Albert (2013, p. 146):

- Detractors: ratings from 0 to 6;
- Passives: ratings of 7 or 8;
- Promoters: ratings of 9 or 10.

The results of the SUS and the NPS were organized on a table (Table 6). The analysis of the results, show the answers were transversal to all the participants, giving all the 8 women the same answers. In terms of system usability score, it is always 100%, which means that, according to the interpretation of Tullis & Albert previously presented (2013, p. 143) the proof of concept is acceptable. For the net promoter score, the results were 10 all across the responses, meaning that the participants are all promoters of the proof of concept.

	SUS											
Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	SUS Score	NPS Score
MN2379	5	1	5	1	5	1	5	1	5	1	100%	10
MS0432	5	1	5	1	5	1	5	1	5	1	100%	10
MN1841	5	1	5	1	5	1	5	1	5	1	100%	10
JA2426	5	1	5	1	5	1	5	1	5	1	100%	10
IF1063	5	1	5	1	5	1	5	1	5	1	100%	10
SP0613	5	1	5	1	5	1	5	1	5	1	100%	10
MM1023	5	1	5	1	5	1	5	1	5	1	100%	10
JP1293	5	1	5	1	5	1	5	1	5	1	100%	10

Table 6 - Table created for organizing the SUS and NPS results

Overall, it is possible to conclude that all eight participants carried out usability tests with no major errors that could compromise the designed prototypes, and enjoyed the proposed project, as one can see by the results of the system usability scale and the net promoter score.

In the next section of the document, the implications of the usability evaluation results towards the design are presented and discussed.

6.5. Implications for design

After analyzing the carried usability tests, it is possible to conclude that all seven tasks were successfully carried out, without any major errors that would not allow the participant to conclude the task. Although some tasks presented some errors, the errors did not prevent users from completing them. With these results, previously presented and analyzed, it was possible to conclude that there was not any task that needed any major design alterations since all participants were successful in completing the tasks.

As presented in the work plan, it was planned to carry one more set of usability tests after the high-fidelity prototypes, in Unity, were completed. But, after the first round of usability tests in the medium-fidelity stage, it was decided not to carry out another round of tests. This decision was made based on the success of the first carried tests and the positive feedback of the participants towards the developed work.

6.6. Chapter summary

In this chapter it was possible to put into practice all the previous knowledge and the created elements. It was in the phase that the proof of concept started to gain shape and that ideas transformed into a tangible artifact.

The user interface design, through the different prototype phases, and the subsequent evaluation was crucial to understand the quality of the proof of concept, as sometimes, what is firstly idealized does not work in the following phases.

After the medium-fidelity prototypes were finished, the usability tests were conducted and it was possible to assess whether the prototypes were meeting the users needs and desires. The outcome of these tests was extremely positive, since no considerable errors were performed by the users, with all users being able to complete all tasks. The feedback from participants was also very positive, with no major suggestion changes. Likewise, it was decided that it was not necessary to conduct another set of tests for the high-fidelity prototypes. This made the development process more agile and confirmed the user interface was well thought out and developed.

Nonetheless, there are still some functionalities that were planned for in the medium-fidelity prototypes but have not been implemented in the Unity prototypes. These functionalities do not compromise the main goal of the proof of concept, but could be a good improvement to the same. The next chapter will present a recap of the work and highlight the future work

7. Conclusions and final remarks

This chapter is the culmination of this dissertation and the work developed throughout this past year and half. Reflections on the accomplishments and the caveats are presented and discussed here. This chapter also highlights the future work for this project.

7.1. Work developed

This dissertation lasted eighteen months, more or less. The goal of the project was to create a proof of concept of an app that allowed women who have undergone mastectomy to try, virtually and at home, a 3D model of a bra. A bra that was both elegant and functional. The project was intended to fill in the existing gap in the market of elegant bras for post mastectomy, but also as a way of empowering women. The accomplishment of this goal was possible through a user-centered design and participatory design approach that included: interviews, personas, photo elicitation, prototyping and evaluation. These multiple stages of development allowed the necessary improvements that could take place in each stage, for example the design of the bra model that contemplated the desires and needs of the participants, and the different phases the user interfaces prototypes faced.

Working side by side with the end-users was crucial, being this group of participants formed by four women who have undergone mastectomy and three health care professionals. Working with them allowed us to confirm ideas formed during the literature review and to corroborate the assumptions behind the proposed project: that the bra options for women who have undergone mastectomy are not the most elegant nor the most beautiful. Furthermore, the participation of the end-users provided a deep insight of the needs and desires women have towards bras for post-mastectomy, making the design process of the bra model easier and purposeful. So, we can conclude that the participation of this group was of great value, ensuring a methodological robustness of the process.

The user interface prototypes were created without the input of the participants. This took a greater effort from our part, since it was necessary to combine various knowledge apprehended during these last eighteen months, with the correct information to support this creation, as well as the knowledge gained throughout the past academic years. This phase of the project was materialized in a style guide, comprehending the typography, color, logotype, icons, grid and layout. The project took concern in following good design practices and principles, with clear interactions, simple design and an organized screen. Practices that are considered to be followed and presented in the proof of concept.

We realized that the project was ambitious for one person, in the beginning of the development phase and, consequently, multiple adaptations and changes needed to be made. Nonetheless, the main goals of this dissertation were accomplished. In the following section, the strengths and caveats of the project are presented and discussed.

7.2. Strengths and caveats

During this past year and half where the dissertation took place, there were some things that did not go as initially planned. There was the need to adapt and face the challenges that came across, which made the development process more interesting. The first interesting challenge that was faced was regarding breast cancer and the mastectomy process. Before starting to develop any ideas, it was crucial to learn about breast cancer, the mastectomy procedure and the recovery process. Being a completely different field of knowledge, the author had to conduct a thorough research, learning about the physical and psychological impacts the mastectomy produces on women. To complete this understanding, it was also decided to work side by side with women who have undergone mastectomy, which was challenging on a personal level. Breast cancer is a delicate subject and some personal testimonies can be very intense and hard to listen to. Nonetheless, it is considered that this was an essential part of the project and offered a deeper knowledge regarding this subject, with a good base to support the development phase.

The other challenge that was faced was connected with the technological development of the project. This was a parameter of the dissertation that was known to be more complex and challenging for the student, since new technologies needed to be explored and others had to be remembered. The first challenge faced was regarding the intel sensor intended to be used. The sensor was an equipment that we were unfamiliar with, so the exploration of the functionalities was based on online knowledge, through online forums and documentation, as well as through self taught experimentation. After several tests and experimentations, it was understood that this would not produce the desired effect. While the goal was to use the sensor as a way of measuring between an x an y axis, the sensor could only measure the depth, so the z axis. For measuring between the x and y axis, it was necessary to develop an equation that, when runned through the code, would be able to measure the desired points. After several attempts, it was decided to abandon the use of this sensor and the possibility for the users to virtually retrieve their bust measures. However, this functionality was still prototyped, as a way of showing the users how it would work. All in all, this still attends to the requirements of a proof of concept.

The high-fidelity prototypes, created in unity, present some caveats. As stated in the section **6.2.3 - High fidelity prototype**, there were a few functionalities that were not completed in this phase. The virtual dressing room screen has incomplete functionalities: zooming in the 3D elements; rotating and having a 360º overview; taking a photo. Various attempts were made to complete the implementation of these functionalities, but this was revealed not to be possible. Nonetheless, since these functionalities do not limit the usage of the prototype and do not compromise the main goal of the proof of concept, these functionalities are considered secondary in the overview of the development of the project. Furthermore, the development of these aspects can enter in the list of future work to be carried out. Being this dissertation materialized in a proof of concept, there is always room for future work and improvements.

Other points that also entry on the list of possible work to be done, in the future, are:

- **Connecting** the proof of concept with the **in3d app**, being the users able to scan their bodies and create a 3D avatar easily;
- Having the **gallery function** working, with photos taken in the virtual dressing room;
- **Improving** the **background** of the virtual dressing room;
- **Creating** more **3D bra models**, which broadens the range of options for the users. Something that was shared, by the participants of the participatory design activities, was the need to have a bra where the straps could have various positions, for example crossing in the back.

Still, it is important to notice that the goals for this dissertation are considered to be complete. First, we successfully created a proof of concept that allows women who have undergone mastectomy to virtually try, at home and through a 3D avatar, a bra that was designed based on their desires and needs. This shows that the concept of adaptive fashion was taken into consideration when designing the bra model, since it is something that the women find practical but also elegant, with a fashionable sense to it. Linking to this, there was also the concept of enclothed cognition that was introduced in the literature review and state of the art. During the various activities that took place during the development of this project, the women participants shared their thoughts and opinions regarding this concept and whether fashion and undergarment options influenced their psychological state. When we confirmed this to be true, we were certain that it was vital to have an undergarment model that reflected the delicacy women look for when choosing a bra. To work side by side with end users, resorting to a participatory and user-centered process, engaging them in multiple stages of development was also a very enriching experience. The final aspect that we wish to highlight is the positive reaction to the user interface design created. We expected that adjustments and a second round of usability tests would be necessary, however because the first set of usability tests were a success, there was no need to conduct any more tests nor to implement significant changes in the user interface. Finally, looking back at the apps analyzed in the beginning of this work, we can say that the proposed proof of concept presents some distinct functionalities that are not available in the analyzed fashion apps, such as the possibility to retrieve oneself measurements to choose the best fitting size.

7.3. Final remarks

Personally, it was a great challenge to work on this dissertation. But it was also with great enthusiasm that I proposed this topic and developed this project. Firstly, it was extremely rewarding to work side by side with a group of women who so kindly gave their testimonies, helping me to understand a reality that is not my own. This dissertation also allowed me to apply a solid methodology in a more practical context. It allowed me to work on an area where my interests truly reside - design - and another that awoke an interest and made me research and learn more - health. When proposing this topic, one of my personal goals was to create a project that could produce a positive impact in society, dwelling on a niche of population that is often forgotten. And it is with confidence that I say that this goal was achieved. This research enriched my experience and knowledge on various levels, making me

perform different tasks and roles as a way of completing this dissertation. Summarily, it is possible to state that this dissertation taught me a lot, aligned with a correct and structured process. It also enriched my personal and professional experience.

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Annexes

Annex 1 - Request for ethical approval

FACULDADE DE PSICOLOGIA E DE CIÊNCIAS DA EDUCAÇÃO UNIVERSIDADE D COIMBRA

Formulário para submissão de projetos à
Comissão de Ética e Deontologia da Investigação (CEDI) da FPCE-UC

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1. Título de projeto: Adaptive fashion and digital Technologies in post mastectomy: undergarment personalization as a way of empowering women

Moda adaptativa e tecnologias digitais em pós mastectomia: personalização de roupa interior como forma de capacitar as mulheres

2. Identificação dos investigadores:

2.1. Nomes das investigadoras proponentes: Maria de Nolasco Santos, Carla Carvalho, Paula Alexandra Silva

Endereço de correio eletrónico: marian.santos14@gmail.com, ccarvalho@fpce.uc.pt, paulasilva@dei.uc.pt

2.2. Nomes das investigadoras responsáveis (no caso de não ser(em) o(s) investigador(es) proponente(s):

3. Âmbito de realização do projeto

3.1. Âmbito principal de realização do projeto

Mestrado x Doutoramento □ Pós-Doutoramento □ Outro (especificar)

3.2. Se o projeto principal englobar outros estudos (por exemplo, teses de mestrado e/ou doutoramento), especifique: Tese de Mestrado em Design e Multimédia, pela Faculdade de Ciências e Tecnologia da Universidade de Coimbra

4. Duração do projeto (datas de início e fim): 01/ 03 / 2022; 30 / 09/ 2022

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5. Sumário do projeto (problema de investigação, sua relevância e objetivos) (até 1500 caracteres sem espaços):

As mulheres submetidas a mastectomias enfrentam não só as consequências físicas que o cancro acarreta, mas também as psicológicas. A auto-estima das mulheres é claramente abalada e muitas delas chegam mesmo a perder o sentimento de feminilidade. Interligando com a questão da auto-estima, podemos questionar se as opções de soutiens para pós mastectomia, a que estas mulheres têm acesso, contribuem positivamente, ou não, para esta dimensão psicológica. Assim, o projeto tem como objetivo integrar mulheres que foram submetidas a mastectomias, médicos e/ou enfermeiros e psicólogos, no desenvolvimento da dissertação, partilhando experiências e necessidades no que toca a opções de *soutiens* adaptados a mulheres que foram submetidas a mastectomias.

O projeto tem por objetivo desenvolver uma prova de conceito de uma aplicação, que permita às mulheres que foram submetidas a mastectomias, experimentarem virtualmente um *soutien*. Este *soutien* é adaptado às suas necessidades, não deixando de lado a questão estética do mesmo.

Ao trabalhar lado a lado com os participantes, é possível desenvolver um protótipo que melhor vá ao encontro das necessidades específicas destas mulheres, tendo também a visão dos profissionais de saúde e que trabalham diretamente com casos de cancro da mama.

Os objectivos a explorar com este estudo são:

- compreender a experiência pessoal, de cada mulher, sobre o pós mastectomia e a compra de *soutiens após* a mastectomias;

- perceber as necessidades e desejos de mulher que foram submetidas a mastectomias relativamente a *soutiens* adaptados;
- perceber se o uso de tecnologias digitais pode ajuda no processo de escolha e compra de um *soutien;*
- aferir se ter a possibilidade de experimentar virtualmente um *soutien* ajuda a adaptar/personalizar as medidas corporais (criando uma opção que sirva da melhor maneira a cada mulher);
- compreender as vantagens de poder personalizar (medidas, tamanhos) e customizar (tecidos, cores, etc.) o *soutien.*

6. Metodologia (plano de investigação e respetivas etapas/cronograma; procedimentos de recolha e registo de dados; tarefas exigidas aos participantes e sua duração; intervenções a realizar, se aplicável; instruções; instrumentos a usar, que poderão ser anexados a este formulário) (até 2000 caracteres sem espaços):
A metodologia a ser utilizada designa-se de co-design, onde o investigador trabalha lado a lado com os participantes e que são também os utilizadores finais do serviço proposto. Para a componente da investigação que requer a interacção com os utilizadores finais/participantes do estudo, prevêem-se as seguintes etapas, a desenvolver idealmente ao longo do mês de setembro:

- Entrevista, semi-estruturada e aprofundada. A entrevista vai ser conduzida online, e tem por objetivo conhecer os participantes e perceber as implicações que ter feito uma mastectomia teve na vida pessoal das mulheres e na compra de roupa interior (5 dias). Tempo previsto: 30 minutos.
- Elicitação de fotos, de forma a que sejam despoletadas memórias relativamente à experiência de comprar um soutien após o procedimento cirúrgico, quais as experiências pessoais, dificuldades e necessidades, abrindo espaço à discussão. Esta atividade também irá ser online, através da plataforma Zoom (5 dias).
- Avaliação dos protótipos criados, através de uma atividade de testes informais designados de "quick and dirty" numa fase mais inicial de protótipos. Esta atividade será feita de forma remota. Para avaliar protótipos mais avançados, relativos ao trabalho de dissertação, serão realizados testes de usabilidade. Estes testes, feitos presencialmente, são compostos por pequenas tarefas, relativas ao trabalho desenvolvido, e que os participantes têm de levar a cabo. Isto faz com que seja possível perceber se o trabalho desenvolvido está a ir ao encontro das necessidades e expectativas (5 dias).

7. Participantes e recrutamento

7.1. Número de participantes previsto
Total: 10 Por estudo (se aplicável):

7.2. Características dos participantes (por exemplo, idade, sexo, condição clínica, social, educativa, etc.): Os participantes do estudo serão mulheres participantes que foram submetidas a mastectomias, como forma de combater o cancro da mama (4 a 5) e profissionais de saúde, tais como médicos e/ou enfermeiros e psicólogos (2 a 5) com experiência profissional na área oncológica, especificamente em situações relativas a cancro da mama. O estudo será divulgado junto de contactos pessoais e ainda através do Núcleo do Centro da Liga Portuguesa Contra o Cancro, que informalmente já se mostrou disponível para colaborar (Anexo 1). Às pessoas voluntárias do estudo, e que preencheram o documento de consentimento informado, será solicitado um contacto exclusivo para o agendamento das atividades propostas para o desenvolvimento deste projeto, e que não será utilizado para outro fim. As atividades serão apresentadas e explicadas aos participantes, consistindo estas em: entrevistas semi-estruturadas e aprofundadas, conduzidas online, e com uma duração a não ultrapassar os 30 minutos (Anexo 2).

Estas entrevistas são direcionadas a todos os participantes (mulheres e profissionais de saúde) e têm por objectivo entender as experiências pessoais no que toca à mastectomia e nas escolhas de roupa interior; Elicitação de fotos, só direccionada a mulheres submetidas a mastectomia, com uma duração não superior a 15 minutos, e que tem por objectivo despoletar memórias e iniciar a conversa sobre as experiências pessoais, dificuldades e necessidades relativas a comprar um soutien pós mastectomia (Anexo 3). A última atividade também contempla só as mulheres submetidas a mastectomia e consiste em avaliar os protótipos da prova de conceito do projeto. Para este ponto ainda não temos os protótipos a utilizar, pois serão construídos apenas em função das respostas obtidas nas duas etapas anteriores.

7.3. Os participantes são pessoas em risco e/ou vulneráveis (por exemplo, crianças, reclusos, pessoas legalmente não responsáveis, com deficiência/deterioração cognitiva, ou outra condição de risco/vulnerabilidade)? Não □ Sim x
- Se respondeu "**Sim"**, explicite a necessidade de inclusão de pessoas em risco e/ou vulneráveis: O estudo só poderá ser realizado com a participação destas pessoas. Contudo, a sua realização permitirá avançar no conhecimento científico sobre o assunto. Ademais, como referido anteriormente, ao trabalhar lado a lado com os participantes, é possível desenvolver um protótipo que melhor vá ao encontro das necessidades específicas destas mulheres, tendo também a visão dos profissionais de saúde e que trabalham diretamente com casos de cancro da mama.

7.4. Incentivos oferecidos aos participantes pela sua participação: Não x Sim □
- Se respondeu "**Sim"**, explicite:

a) Pagamento aos participantes Não □ Sim □
Momento de pagamento/montante
b) Outros incentivos (especifique)

7.5. Necessidade e modo de obtenção de autorizações de outras instituições para o recrutamento (por exemplo, escolas, hospitais, empresas, etc.): Não x Sim □
- Se respondeu "**Sim"**, explicite:

7.6. Recolha de dados de caráter sensível dos participantes: Não □ Sim x
- Se respondeu "**Sim"**, explicite esses dados e a razão para os recolher (por exemplo, dados clínicos, profissionais, escolares, económico-financeiros): Os dados recolhidos, principalmente das mulheres que foram submetidas a mastectomias, remetem para situações de vulnerabilidade e muito pessoais. Mas os dados recolhidos, baseados nestas experiências pessoais, sustentam o projecto aqui apresentado e são importantes para corroborar a veracidade do problema inicial. Assim, a recolha destes dados será feita com total segurança e conforto para os participantes, assegurando sempre o anonimato e confidencialidade dos mesmos. A privacidade dos participantes está salvaguardada, tal como a possibilidade de interromper as atividades, caso exista algum desconforto por parte dos participantes. Esta informação é disponibilizada aos participantes no dia da sua participação, quer por escrito, quer oralmente.

8. Consentimento informado dos participantes (a declaração de consentimento informado, quando assinada pelo participante, deverá assegurar a independência deste documento em relação a todos os outros que o referido participante preencha).

8.1. Informação dada aos participantes sobre o estudo e a(s) forma(s) de consentimento. Assinalar a(s) opção(ões) que se aplica(m)*:

x Por documento físico no qual o participante assina o seu consentimento, ou assentimento, ficando com uma cópia (obrigatório se a participação no estudo envolver risco para os participantes).

□ Por informação digital que o participante lê antes de comunicar a decisão de participar (não implicando a assinatura do participante).
x Por explicação oral ou escrita dada ao participante antes de este comunicar a decisão (não implicando a assinatura do participante).

**Em qualquer das opções devem ser anexados a este Formulário os respetivos documentos/informações.*

8.2. Discriminar todas as pessoas ou entidades de quem se deve obter o consentimento informado: Todos os participantes do estudo, tais como: as mulheres submetidas a mastectomias, os médicos e/ou enfermeiros e os psicólogos.

8.3. Participação de pessoas não legalmente competentes para dar o consentimento informado Não x Sim □
- Se respondeu "**Sim"**, anexe o documento informativo sobre o estudo, a proporcionar aos responsáveis legais, e o respetivo consentimento (os responsáveis legais devem ficar com uma cópia).

8.4. Participação de pessoas sem plena autonomia para dar o seu consentimento informado, devido ao seu estatuto social, educacional, profissional, institucional ou outro: Não x Sim □
- Se respondeu "**Sim"**, indique a(s) forma(s) de minimização do risco de influência inapropriada ou coerção para participar no estudo:
- Forma de explicação de que a participação no estudo é voluntária:

8.5. Barreiras linguísticas capazes de afetar o consentimento informado. Não x Sim □
- Se respondeu "**Sim"**, indique forma(s) de ultrapassar essas barreiras:

9. Possíveis riscos para os participantes (ter em atenção que o preenchimento deste ponto deve ser congruente com o ponto **7.3**):

9.1. Riscos para os participantes (por exemplo, físicos, psicológicos, legais, educacionais, económicos, sociais)? Não □ Sim x
- Se respondeu "**Sim"**,
  a) Especifique-o e justifique o porquê de não ser possível a sua eliminação
     Ao serem questionadas sobre esta temática tão sensível e pessoal, pensamentos e sentimentos negativos podem ser despoletados nas mulheres. Contudo, a participação das mulheres neste estudo é essencial para compreender as necessidades e desejos relativos a soutiens pós mastectomia.
  b) Indique eventuais procedimentos destinados a minimizar riscos e a monitorizar a segurança dos participantes:
     No início de cada atividade, é assegurado às participantes, não só o anonimato da sua participação, mas também o seu direito de cessar qualquer atividade assim que sentir qualquer tipo de desconforto. Será disponibilizado o contacto dos membros da equipa de investigação, incluíndo de uma psicóloga.

9.2. Medidas previstas destinadas a gerir eventuais consequências negativas para os participantes (assinalar o que se aplica):
x Indicação para apoio psicossocial
□ Indicação para orientação educativa/formativa
□ Outras (especificar):

10. Engano intencional (apresentar informação falsa ou enganosa; omitir informação que possa ser relevante para a decisão de participação, ou acerca de ações relevantes no contexto da investigação): Não x Sim □

- Se respondeu "**Sim"**:

a) Descreva sucintamente a forma do engano:

b) Indique se existem outras formas de conduzir o estudo sem recorrer ao engano, explicando a razão de rejeição dessas formas:

c) Apresente a explicação dada aos participantes sobre o engano, após a sua participação:

11. Proteção e privacidade dos participantes

Formas de assegurar a proteção e a privacidade dos participantes (por exemplo, não questionar informação pessoal/institucional desnecessária): Irão ser apenas recolhidas informações relevantes para o estudo, como já referido anteriormente. Os participantes terão a possibilidade de não responder a questões que considerem ser intrusivas, colocando em causa a sua privacidade. Podem também desistir de participar no projecto a qualquer momento se sentirem qualquer tipo de invasão à sua privacidade. Os dados recolhidos vão ser armazenados numa pasta privada, sendo que só os investigadores do projecto terão acesso. Estes dados irão ser, posteriormente, analisados pela primeira investigadora e organizados através de tabelas (excel). Os dados recolhidos não irão ser divulgados com terceiros, apenas com os participantes, com a professora orientadora e com o júri arguente da dissertação. Por fim, os dados serão anonimizados, garantindo sempre que não será possível a identificação da pessoa. Todos os dados serão tratados de acordo com as Diretrizes da Universidade de Coimbra para a proteção de dados, que estão alinhados com o Regulamento Geral de Proteção de Dados Pessoais (RGPD; Regulamento nº201 6/679 do Parlamento Europeu e do Conselho, de 27 de abril de 2016 - aplicável desde 25 de maio de 2018). Os dados recolhidos serão destruídos ao fim de 2 anos.

12. Confidencialidade e/ou anonimato

12.1. Formas de assegurar a confidencialidade e/ou anonimato: Através de um código alfanumérico, constituído pela letra E, seguidas de um número, que segue a ordem pela qual os participantes são entrevistados.

12.2. Para estudos *online* o sítio hospedeiro é o da Faculdade de Psicologia e de Ciências da Educação da Universidade de Coimbra: Não x Sim □ Não se aplica □

- Se respondeu "**Não",** indique o sítio hospedeiro e as garantias de confidencialidade/anonimato: Google Drive partilhada apenas entre as investigadoras, com acesso restrito.

13. Informação pós-estudo:

Forma(s) de comunicar essa informação aos participantes, organizações, entidades envolvidas: Serão disponibilizados (no Consentimento Informado) os e-mails de duas investigadoras para eventuais dúvidas que possam surgir. Prevê-se ainda a divulgação dos resultados do estudo junto da comunidade científica, através de comunicações em Congressos da especialidade e/ou publicações em Revistas na área.

14. Outras informações relevantes

Todas as investigadoras proponentes estão de acordo com esta proposta, pelo que, para facilitar, vai a presente submissão do Projeto ser assinada pelas três investigadoras.

Coimbra, 18 de Julho de 2022

Assinatura(s) do(s) investigador(es) responsável(eis)

Assinado por: **Paula Alexandra Gomes da Silva**
Num. de Identificação: 10592631
Data: 2022.07.18 15:52:37 +0100

CHAVE MÓVEL

Assinado por: **CARLA MARIA SANTOS DE CARVALHO**
Num. de Identificação: 08210398
Data: 2022.07.18 17:46:41+01'00'

CARTÃO DE CIDADÃO

(**Verifique, por favor, se todas as páginas do formulário se encontram assinadas/rubricadas**)

Consentimento informado

Prezado/a participante,

O presente estudo, inserido num projeto de dissertação do Mestrado em Design e Multimédia da Faculdade de Ciências e Tecnologia da Universidade de Coimbra, tem como principal objetivo perceber quais as necessidades, e desejos, das mulheres em relação a soutiens para a fase pós mastectomia. Para isso, será desenvolvida uma prova de conceito que irá permitir às mulheres, que foram submetidas a mastectomias, experimentar em casa, e virtualmente, um soutien que seja adaptado às suas necessidades específicas, não deixando de parte a questão estética.

Toda a informação recolhida será anónima e confidencial, pelo que as respostas obtidas serão agrupadas e trabalhadas estatisticamente em conjunto com as dos demais participantes. As informações recolhidas serão utilizadas para fins de divulgação científica, de acordo com a ética em investigação científica em vigor em Portugal. Salientamos que todos os dados serão tratados de acordo com as Diretrizes da Universidade de Coimbra para a proteção de dados, que estão alinhadas com o Regulamento Geral de Proteção de Dados Pessoais (RGPD; Regulamento nº 2016/679 do Parlamento Europeu e do Conselho, de 27 de abril de 2016 - aplicável desde 25 de maio de 2018).

Note que a sua participação é voluntária, pelo que pode desistir do estudo a qualquer momento, sendo para tal necessário apenas informar a equipa de investigação da sua decisão.

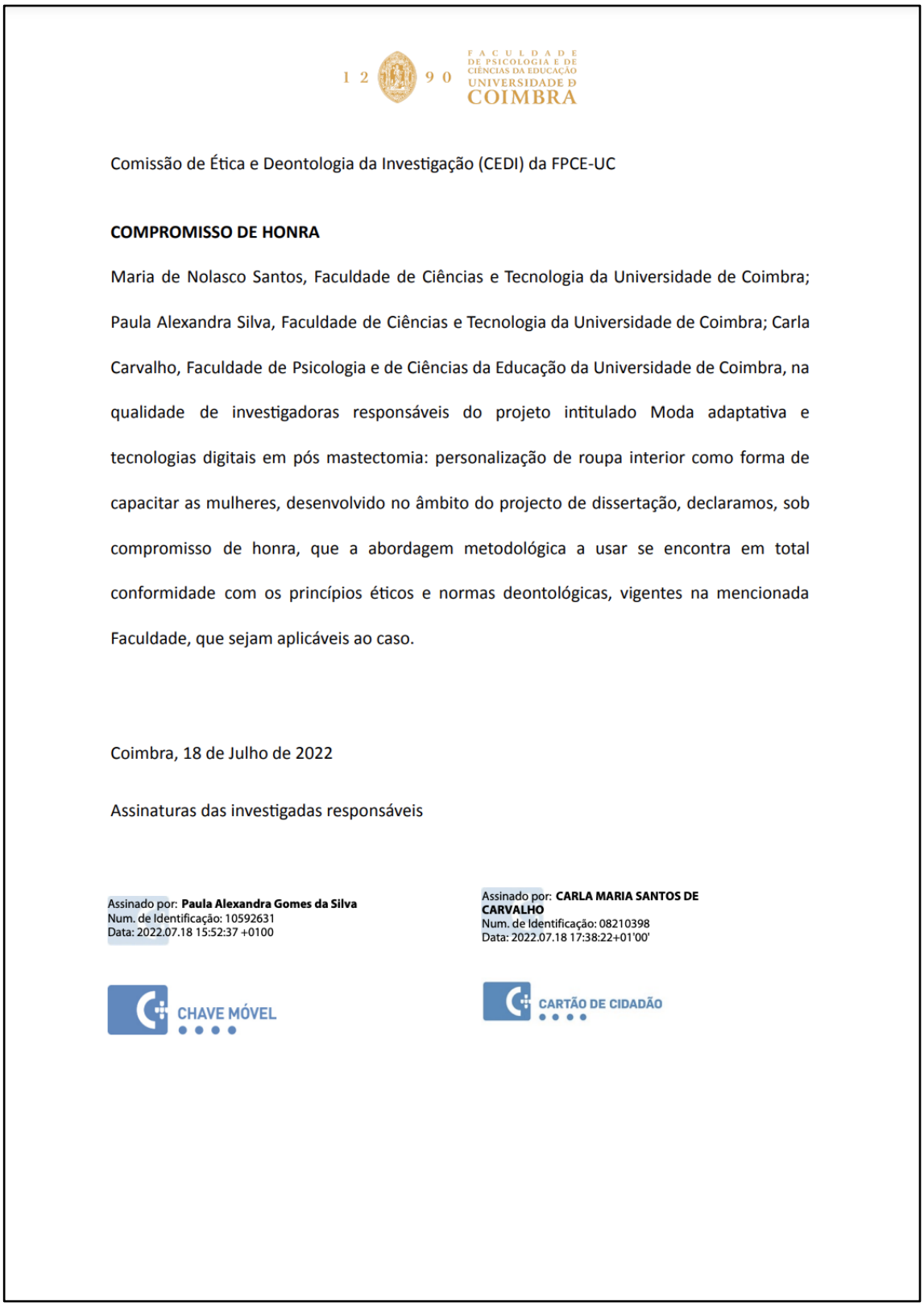
Agradecemos a sua colaboração! Se tiver algum comentário ou dúvida sobre o estudo em questão, por favor entre em contacto com a equipa de investigação, através de um dos seguintes e-mails: marian.santos14@gmail.com; paulasilva@dei.uc.pt, ccarvalho@fpce.uc.pt

Atenciosamente,

A equipa de investigação

Para efeitos de codificação, solicitamos que por favor indique um código alfanumérico, contendo as seguintes informações: Primeira letra do nome próprio e primeira letra do apelido; Dia de aniversário; Últimos dois dígitos do número de telemóvel.

_ _ _ _ _ _



1290 FACULDADE DE PSICOLOGIA E DE CIÊNCIAS DA EDUCAÇÃO UNIVERSIDADE D COIMBRA

Comissão de Ética e Deontologia da Investigação (CEDI) da FPCE-UC

COMPROMISSO DE HONRA

Maria de Nolasco Santos, Faculdade de Ciências e Tecnologia da Universidade de Coimbra; Paula Alexandra Silva, Faculdade de Ciências e Tecnologia da Universidade de Coimbra; Carla Carvalho, Faculdade de Psicologia e de Ciências da Educação da Universidade de Coimbra, na qualidade de investigadoras responsáveis do projeto intitulado Moda adaptativa e tecnologias digitais em pós mastectomia: personalização de roupa interior como forma de capacitar as mulheres, desenvolvido no âmbito do projecto de dissertação, declaramos, sob compromisso de honra, que a abordagem metodológica a usar se encontra em total conformidade com os princípios éticos e normas deontológicas, vigentes na mencionada Faculdade, que sejam aplicáveis ao caso.

Coimbra, 18 de Julho de 2022

Assinaturas das investigadas responsáveis

Assinado por: **Paula Alexandra Gomes da Silva**
Num. de Identificação: 10592631
Data: 2022.07.18 15:52:37 +0100

CHAVE MÓVEL

Assinado por: **CARLA MARIA SANTOS DE CARVALHO**
Num. de Identificação: 08210398
Data: 2022.07.18 17:38:22+01'00'

CARTÃO DE CIDADÃO

Figure 68 - Document submitted for ethical approval

Annex 2 - Initial work plan

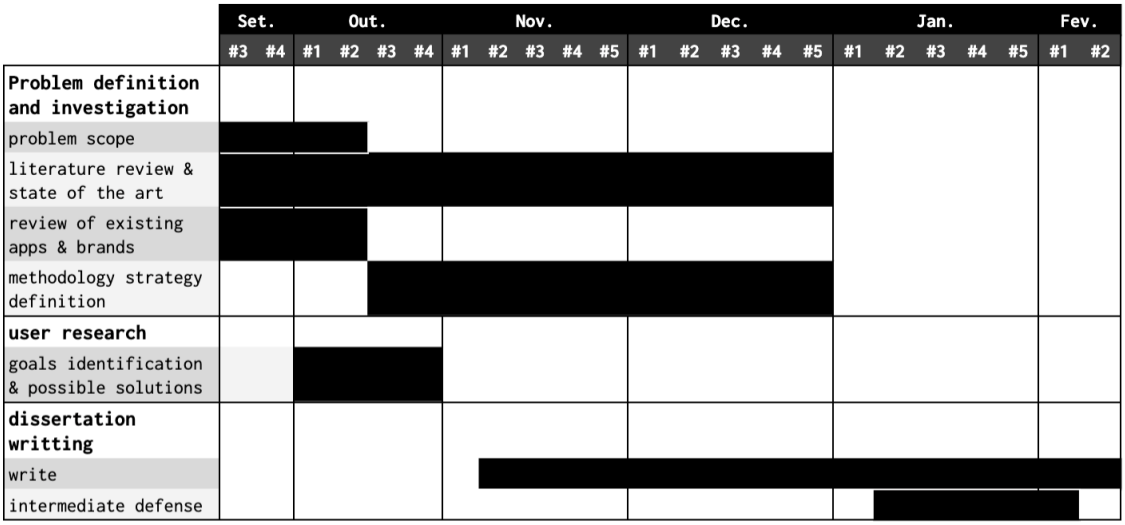


Figure 69 - First Gantt chart for the first semester

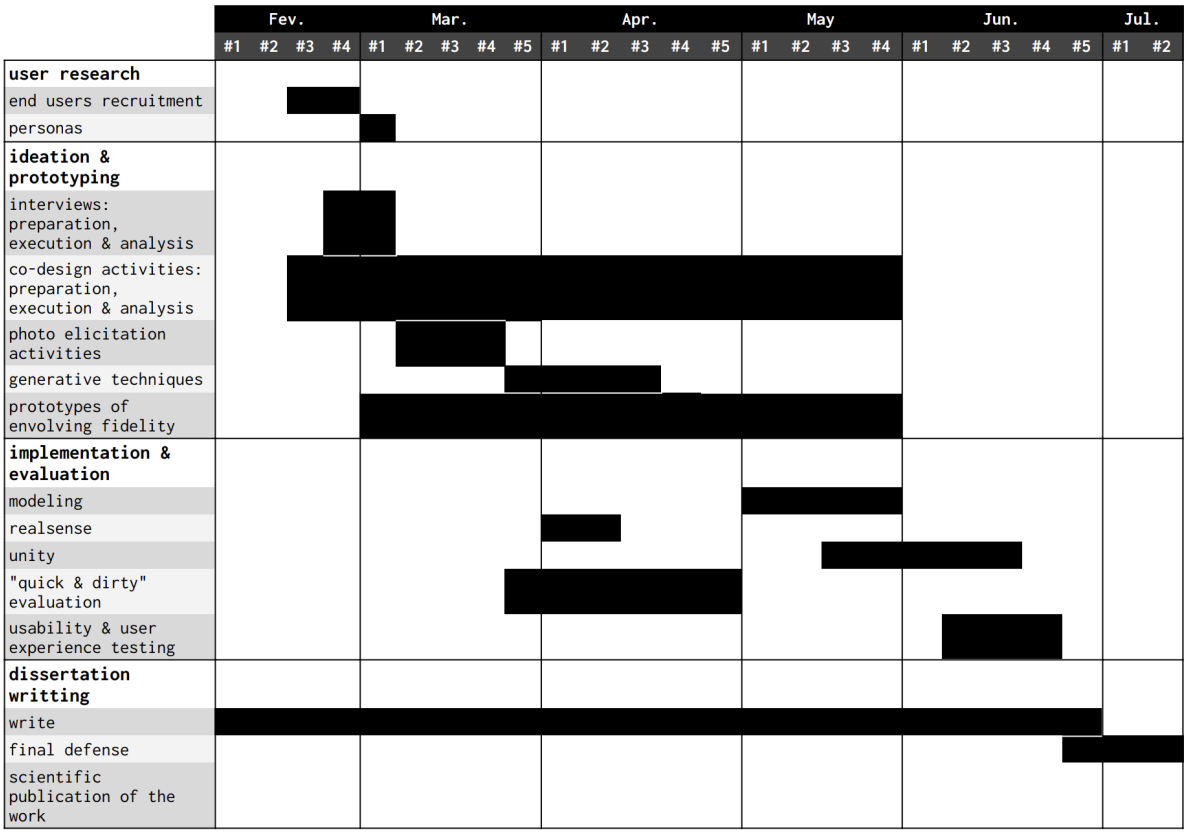


Figure 70 - First Gantt chart for the second semester

Annex 3 - Initial storyboards

Figure 71 - First created storyboards

Annex 4 - Interviews transcripts

//script entrevista

//introdução

Bom dia.
Antes de mais, quero agradecer por ter mostrado interesse e disponibilidade para participar neste estudo que estou a desenvolver.
Tendo em conta o carácter voluntário desta entrevista, se em algum momento não se sentir confortável para responder a uma questão ou sentir que quer parar a entrevista, está à vontade e no seu direito. Nesse caso, diga-me e paramos imediatamente. Como é referido no documento de consentimento informado, é totalmente livre de recusar, em qualquer ponto, contribuir para este estudo. O consentimento pode ser retirado em qualquer momento, sem qualquer consequência, bastando apenas informar-me.

//apresentação

A presente entrevista tem como objectivo perceber a sua experiência pessoal no que toca ao procedimento de uma mastectomia, e o impacto que esse procedimento provoca na vida de cada uma das mulheres. Mais especificamente, queremos perceber como é o processo de encontrar e comprar um soutien após uma mastectomia.

Esta entrevista está inserida num conjunto de atividades que irão contribuir para o desenvolvimento do trabalho da minha dissertação.

O objectivo da dissertação passa pelo desenvolvimento de uma prova de conceito de uma aplicação pensada para mulheres que foram submetidas a mastectomias. Através desta aplicação, vai ser possível experimentar virtualmente, e em casa, um soutien que é adaptado completamente às necessidades específicas de cada mulher. Vai ser ainda possível personalizar, e customizar, este soutien, alterando medidas (consoante as medidas de cada mulher), copas, cores, texturas, etc. O que se pretende com este trabalho é apresentar uma opção bonita e elegante de soutiens, não deixando de parte o aspecto funcional que o soutien precisa de ter.

Assim, pretendo trabalhar lado a lado com quem vai usufruir deste serviço, ou seja, as mulheres que foram submetidas a mastectomias, neste caso, consigo. Isto vai permitir que eu adquira um maior conhecimento sobre as necessidades específicas de cada mulher, percebendo os desejos e expectativas de cada uma em relação a esta temática.

Esta entrevista vai ter uma duração de aproximadamente meia hora.

//começar a conhecer

Esta entrevista, apesar de ser gravada, vai ser mantida no anonimato. Sendo assim, não vão ser revelados quaisquer nomes. Foi criado um código identificativo para cada um dos participantes. O seu é o E1

Para começar, queria saber alguns dados sociodemográficos, tais como:

- Idade;
- quando foi diagnosticada

//mastectomia

a. Antes de ser submetida à mastectomia, que outros tratamentos foram usados para combater o cancro da mama?
b. Depois de ser submetida à mastectomia, quais foram os maiores ajustes que teve de fazer, em particular no que diz respeito às suas escolhas de vestuário e estilo de vida? (exemplo: estilo de vida que levava, peças de roupa, etc)
c. Qualquer transformação no corpo tem implicações, não só a nível físico como também a nível psicológico.
   Mentalmente, quais foram as maiores implicações que a mastectomia provocou? Como é que a mastectomia a afetou?
d. Esta questão pode ser muito pessoal e, se não se sentir confortável para responder, por favor diga-me. Porque é que decidiu não fazer uma reconstrução do peito?

//roupa e experiência de compra

Tendo em conta que o meu trabalho está muito interligado com moda, roupa e até com a própria experiência de comprar roupa, no pós mastectomia, é para mim importante perceber quais as necessidades e desejos de cada mulher. Só assim me será possível desenvolver um trabalho que tenha em consideração as necessidades e expectativas de pessoas como a __NOME__.

1. Como é que a mastectomia afetou a sua escolha de peças de roupa?
2. Quando tem de comprar um *soutien* agora, que atributos é que, para si, são fundamentais que este tenha? Só funcionais (sem aros, enchimento, tem em consideração o tecido, etc) ou também procura peças que sejam bonitas e elegantes (aspecto estético)?
3. No que toca às opções que existem no mercado de *soutiens* para mulheres que foram submetidas a mastectomias, qual é a sua opinião? Acha que existem opções bonitas, elegantes, que encaixam no seu estilo, acessíveis, etc?
4. Antes da mastectomia, como era a sua experiência de comprar roupa (peças de roupa no geral, não só roupa interior)? (Preferia comprar online ou em loja; se não tinha problema de pedir ajuda aos colaboradores da loja, etc)

5. Quando precis a de comprar um *soutien*, qual a situação que a deixa mais confortável? Em loja ou online? (Online não precisa de interagir com colaboradores, não precisa de explicar a situação, etc)

`//likert scale`

Nesta parte da entrevista, vou pedir que avalie as questões que vão ser feitas. Para avaliar vai recorrer à escala de: "concordo completamente" a "discordo completamente"

1. Peças de roupa que assentem bem no corpo, e que sejam opções bonitas, têm um impacto positivo na auto-estima.
2. As opções de *soutiens* para mulheres que foram submetidas a mastectomias não são as mais elegantes e bonitas
3. As opções existentes de *soutiens* para mulheres que foram submetidas a mastectomias fazem-me ter saudades de opções que utilizava antes da operação
4. A existência de uma aplicação que me permita escolher, experimentar, personalizar e comprar *soutiens* online é uma mais valia.

`//wrap up`

No que toca a perguntas, é tudo da minha parte. Não sei se tem alguma coisa que queira acrescentar, ou alguma dúvida que tenha.

Mais uma vez, obrigada por participar nesta entrevista e neste trabalho.

`//enclothed cognition`

Como já referi, a parte de perguntas já terminou e agora queria abrir um bocadinho o espaço para conversar um pouco, e partilhar ideias, sobre um termo utilizado na psicologia da moda.

Muito resumidamente, enclothed cognition é um termo utilizado para descrever a influência que uma peça de roupa pode ter no estado mental, e nos comportamentos, de quem a está a usar.
Uma peça de roupa tem, agregado, por um lado, o significado simbólico que cada peça de roupa acarreta (por exemplo: casaco de cabedal acarreta um significado de rebeldia), e por outro, a experiência física de a utilizar (exemplo: usar roupas confortáveis acaba por estar interligado com tempo de relaxar). E são estes dois fatores que, em conjunto, são responsáveis pelos efeitos psicológicos provocados, pela peça de roupa, em quem a usa. Assim, esta experiência de utilizar uma peça de roupa, acaba por despoletar conceitos abstractos distintos em cada um de nós. Por exemplo, utilizar uma determinada peça de roupa interior pode ter o poder para influenciar e aumentar a confiança e auto-estima de cada um.
Abro agora o espaço para uma conversa sobre o tema, uma partilha de ideias.

A _NOME_ acha que este termo, enclothed cognition, representa bem a realidade?

//possíveis tópicos para a conversa

- Acha que a roupa tem a capacidade de alterar o estado mental de quem a está a usar?
- Aumentar ou diminuir a confiança de cada um?
- Usa a roupa como forma de expressão, ou como forma de aumentar a sua auto-estima?

Annex 5 - Womens' common ground affinity diagram

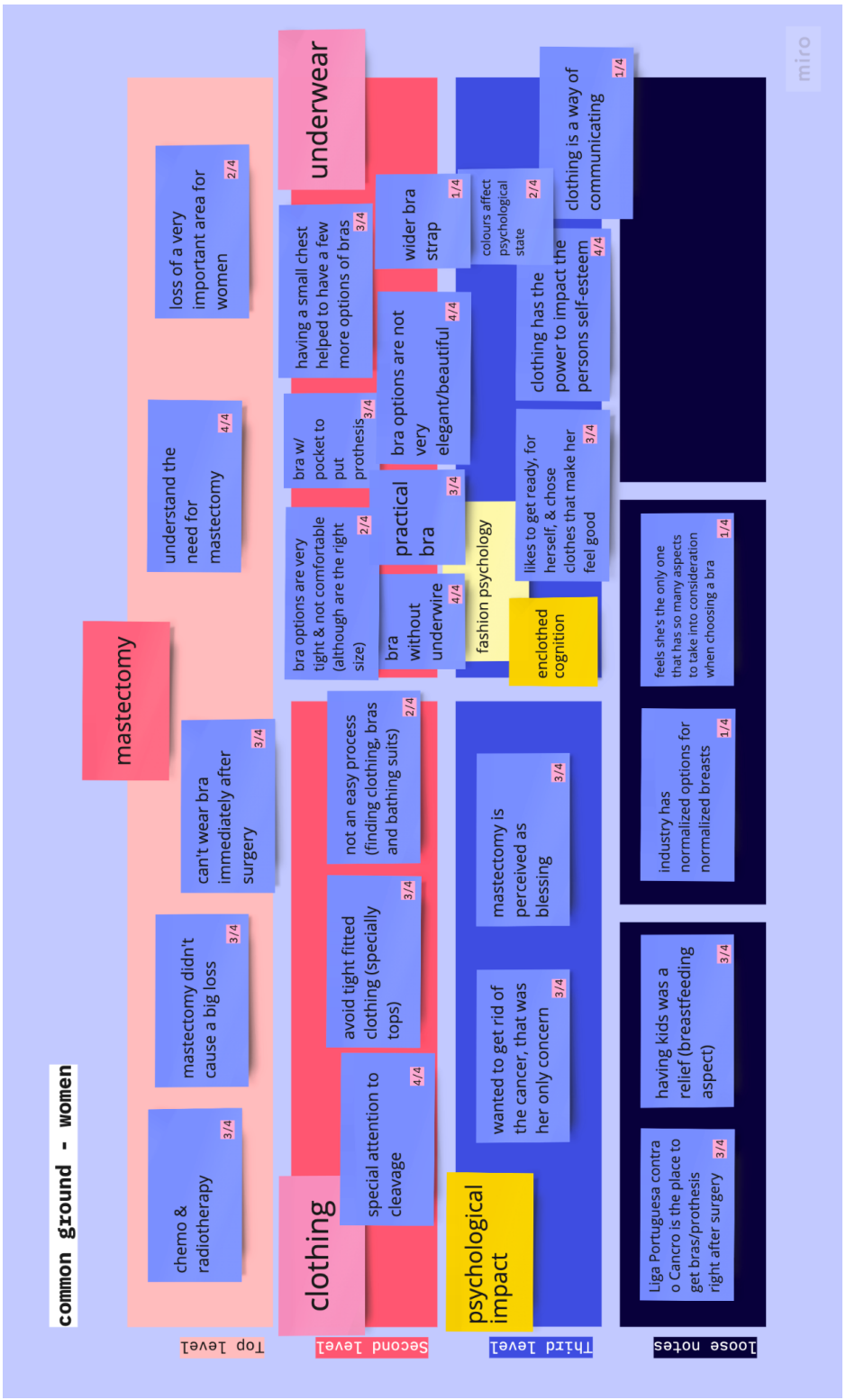


Figure 72 - Womens' common ground affinity diagram[29]

[29] Link to affinity diagrams

Annex 6 - Health care professionals common ground affinity diagram

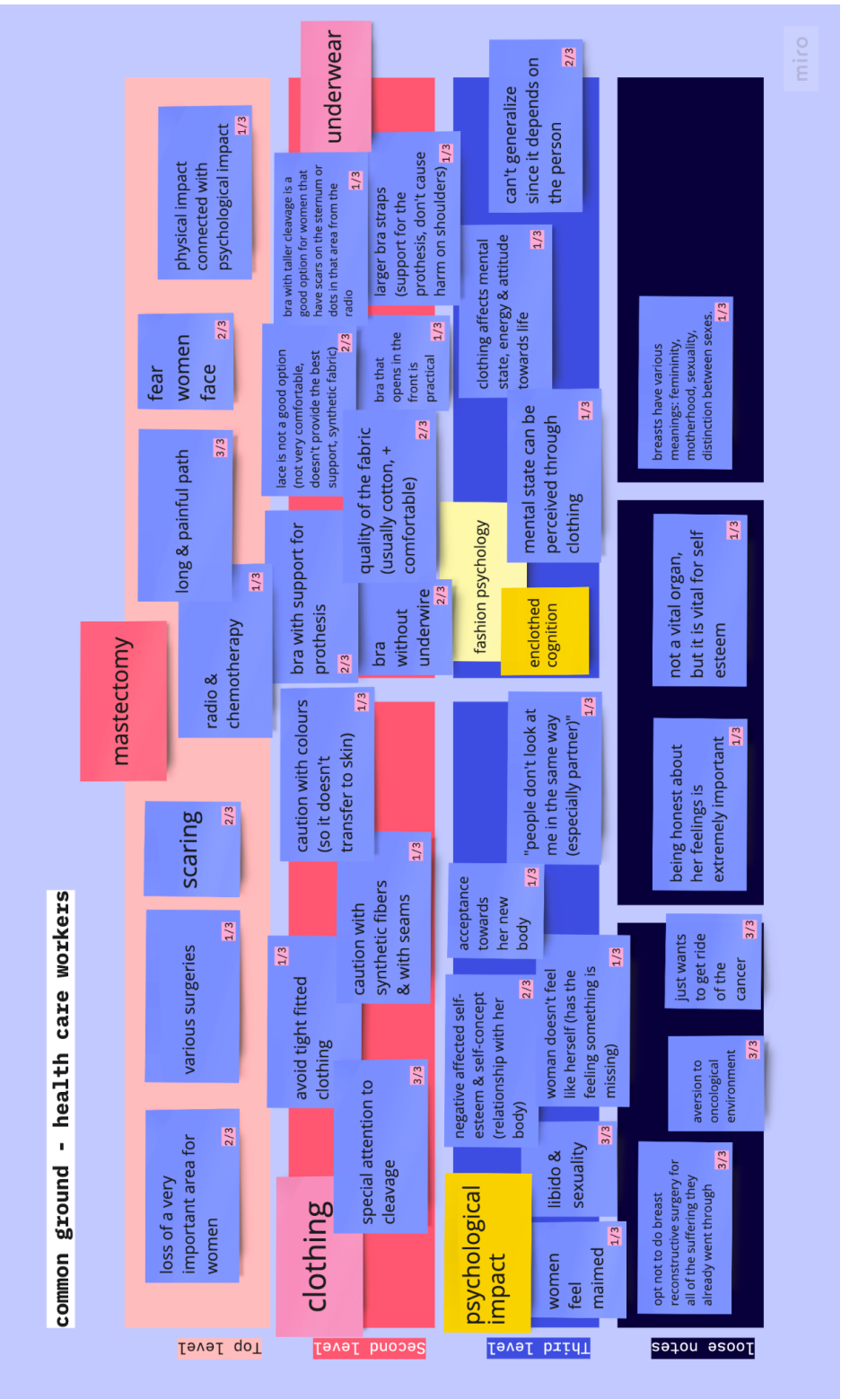


Figure 73 - Health care professionals' common ground affinity diagram[30]

[30] Link to affinity diagrams

Annex 7 - Common ground between both groups affinity diagram

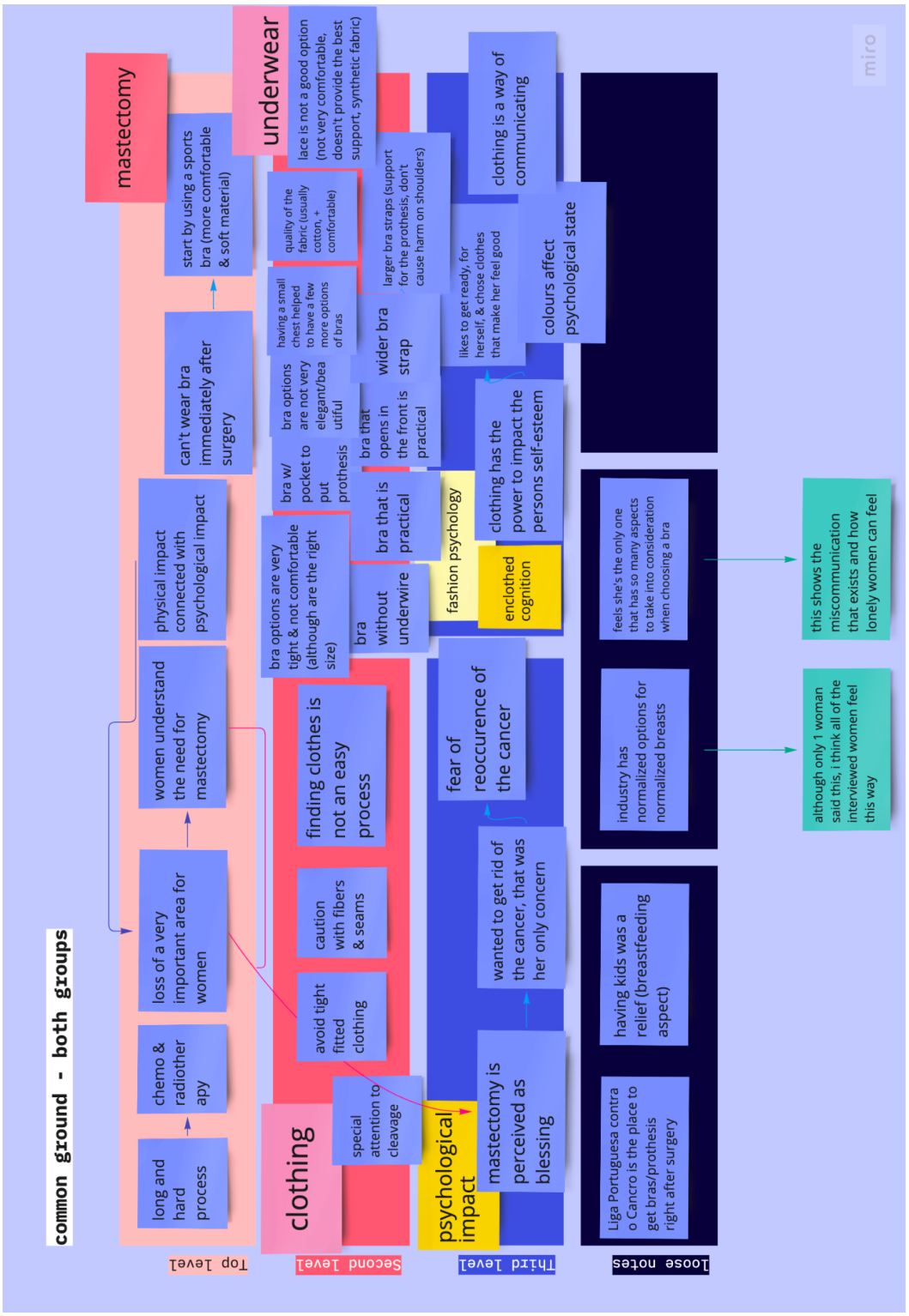
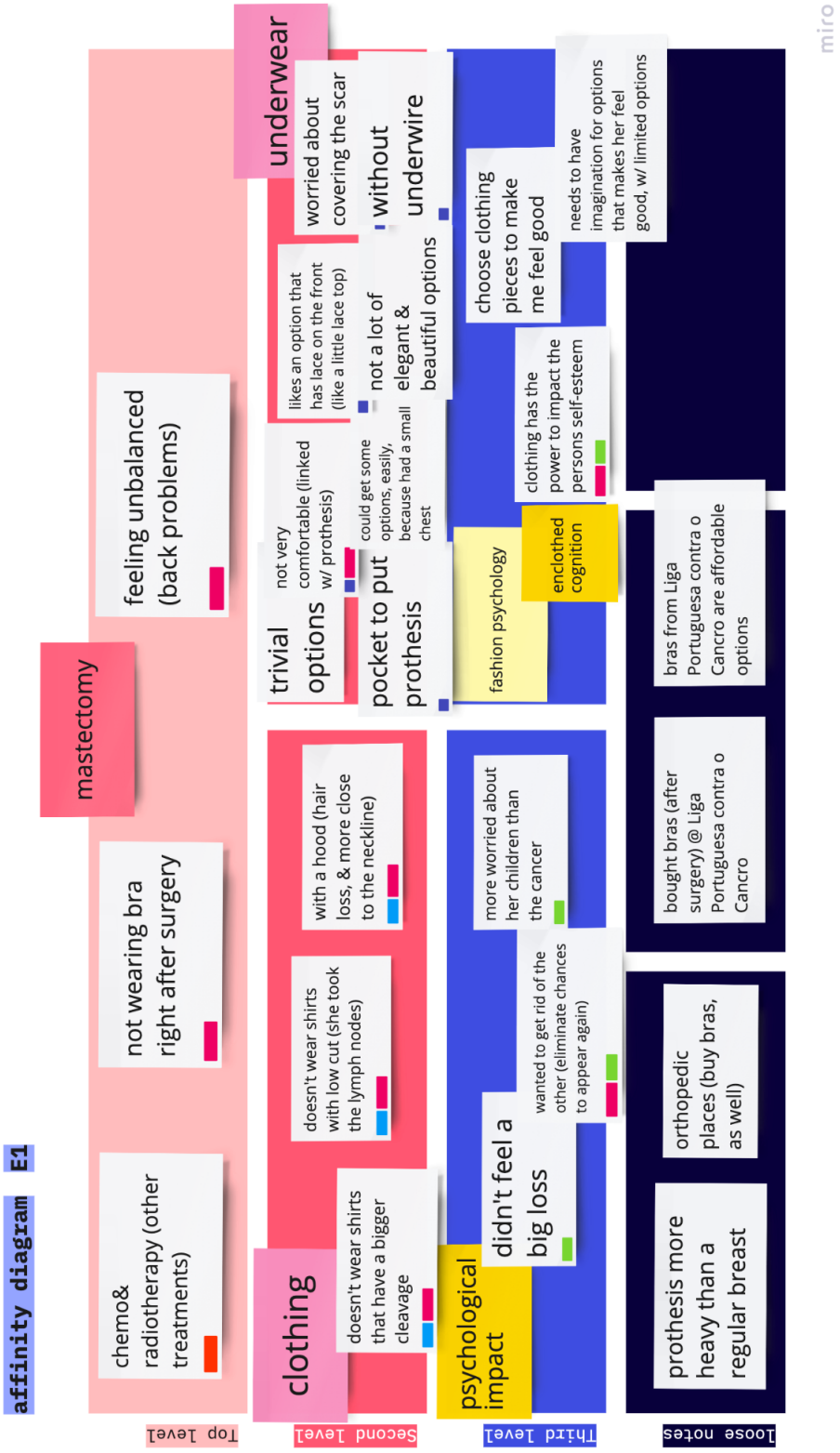
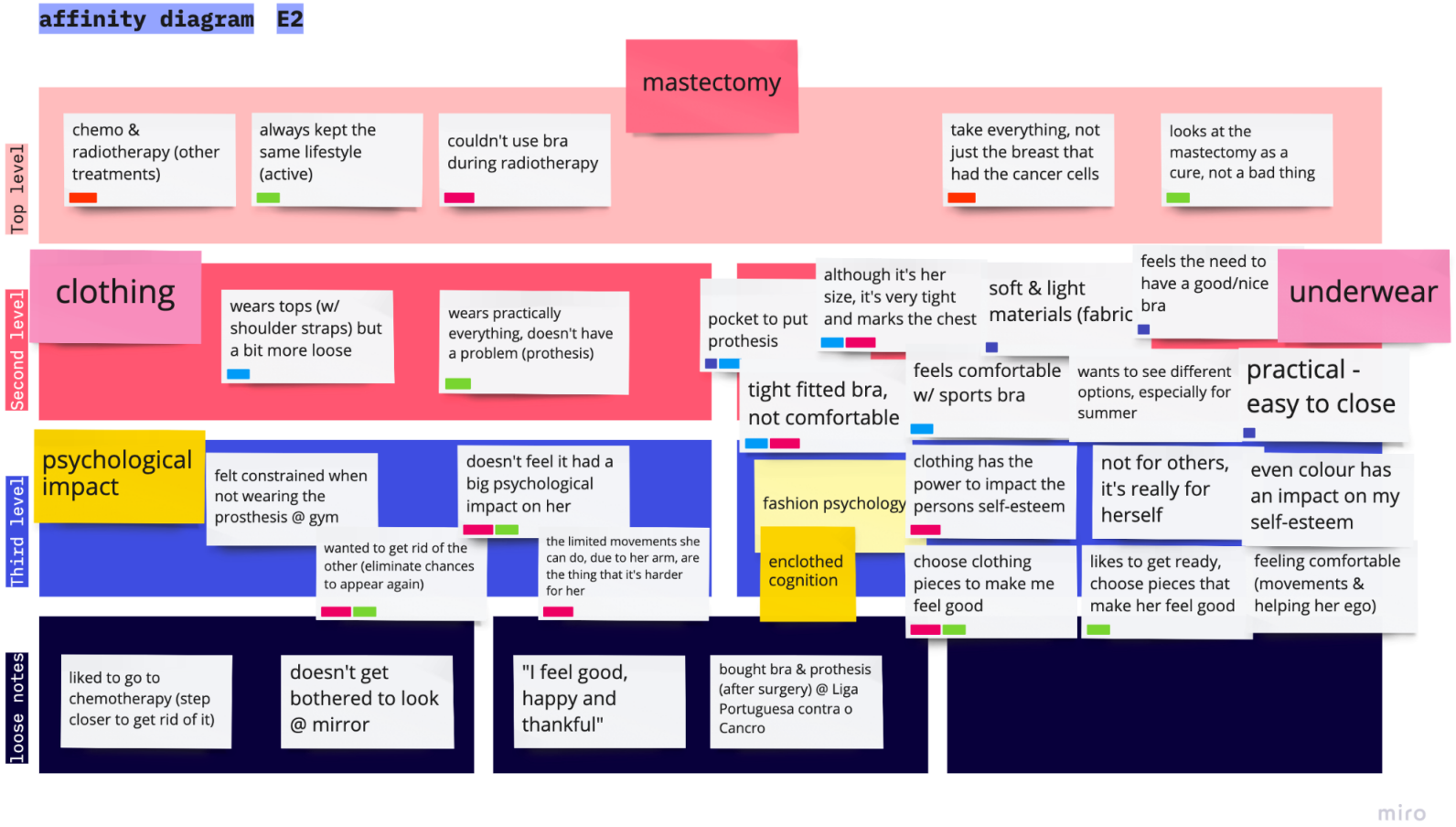


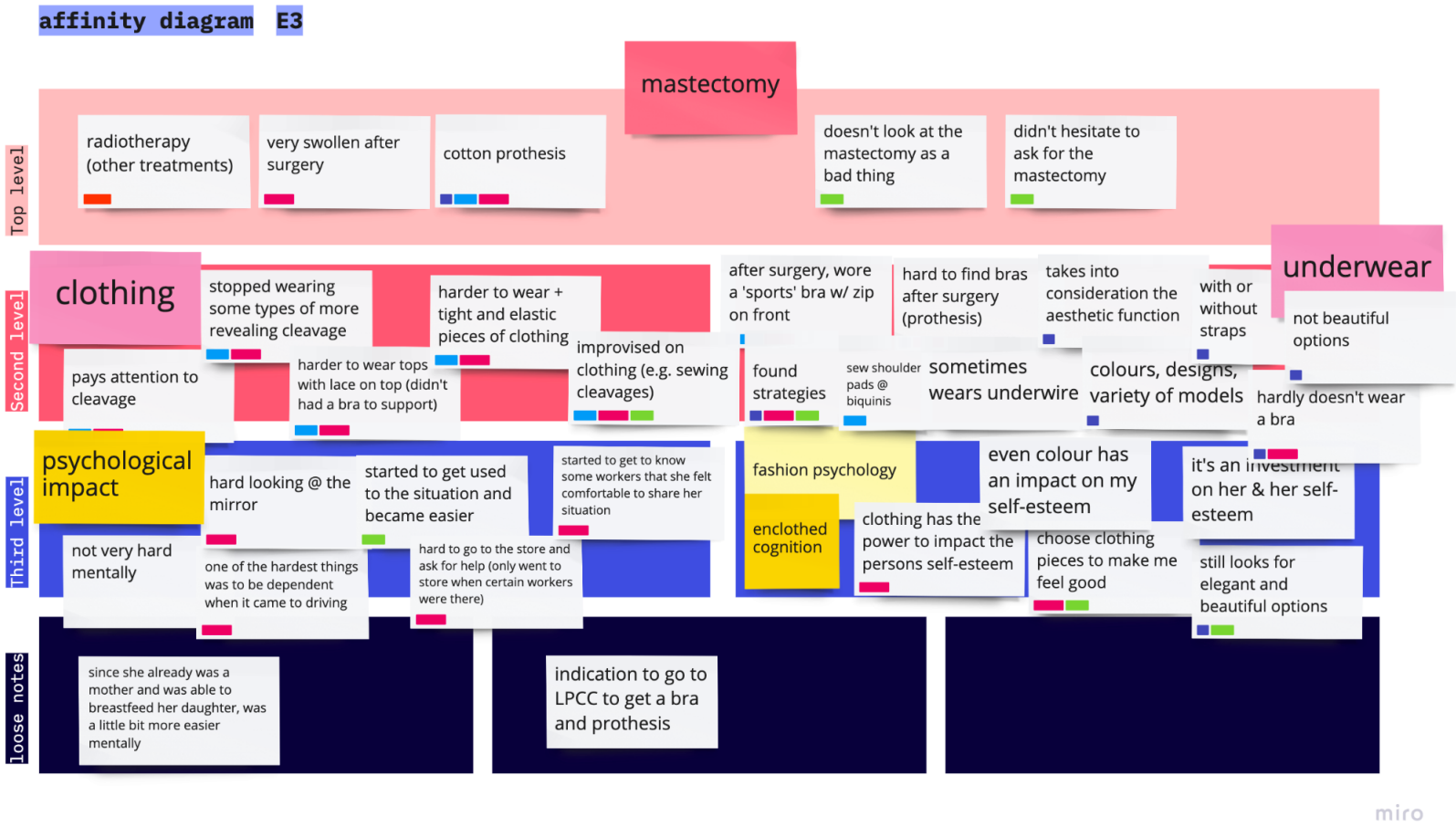
Figure 74 - Common ground between both groups' affinity diagram[31]

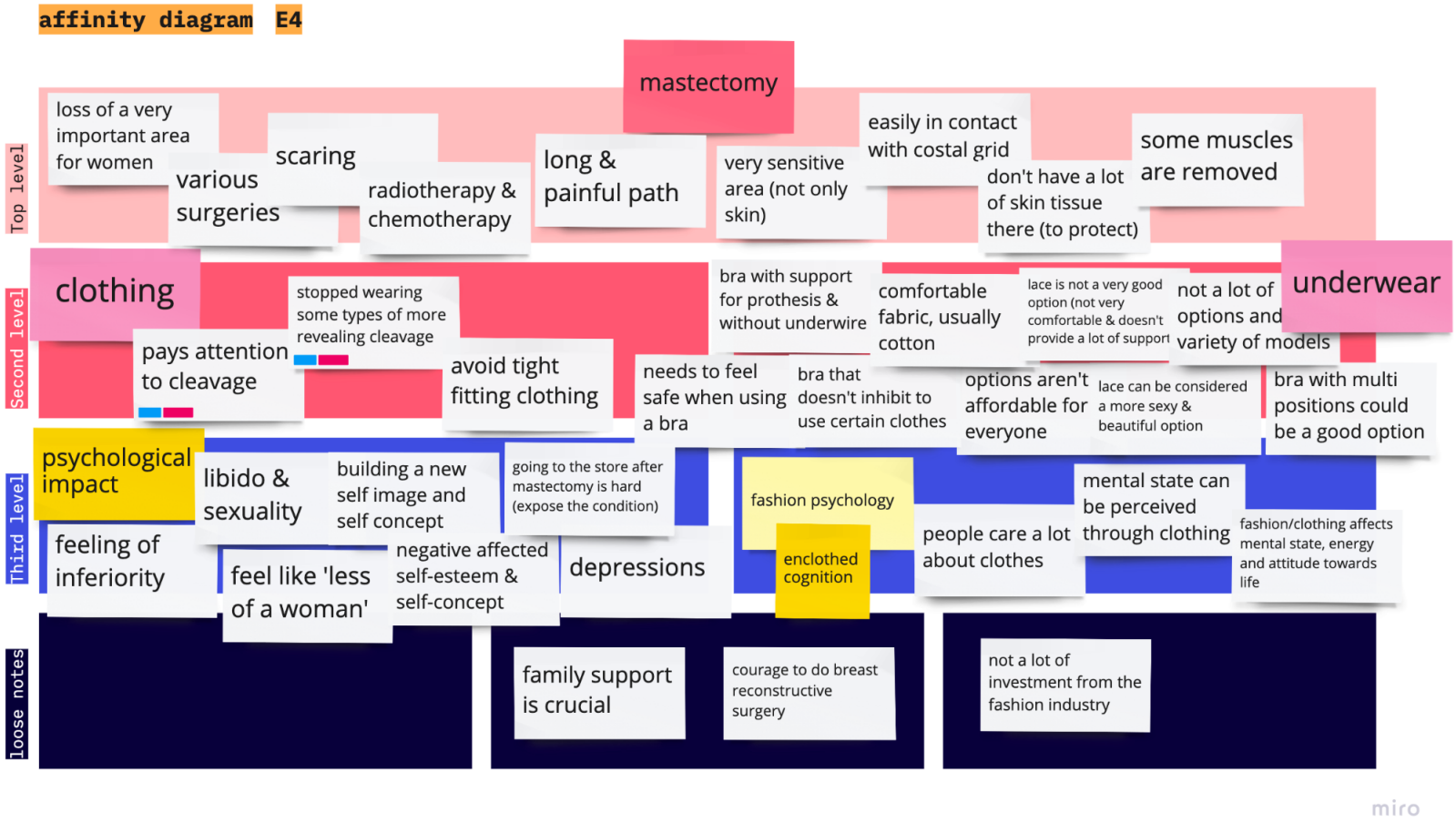
[31] Link to affinity diagrams

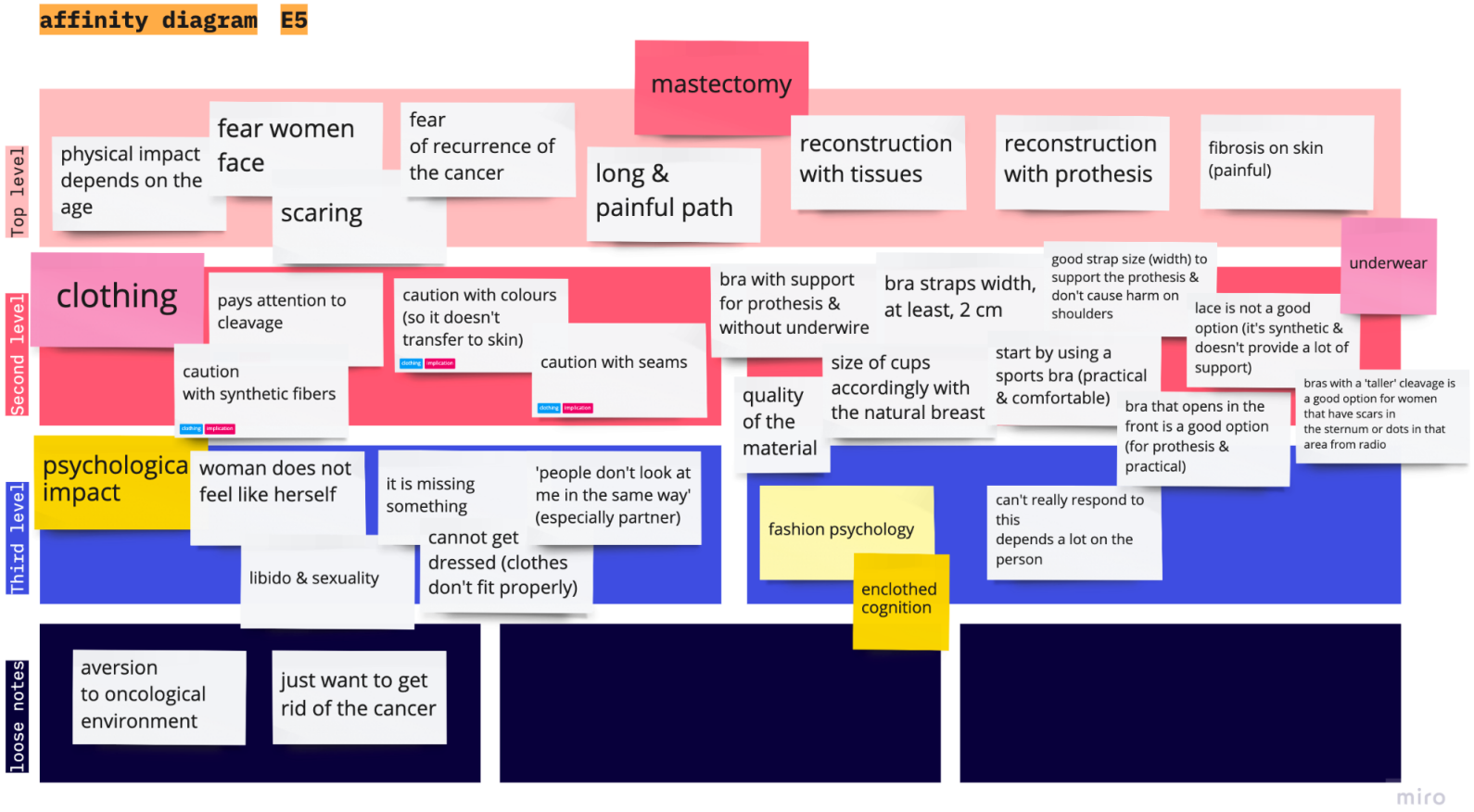
Annex 8 - Affinity diagrams of interview analysis per interviewee

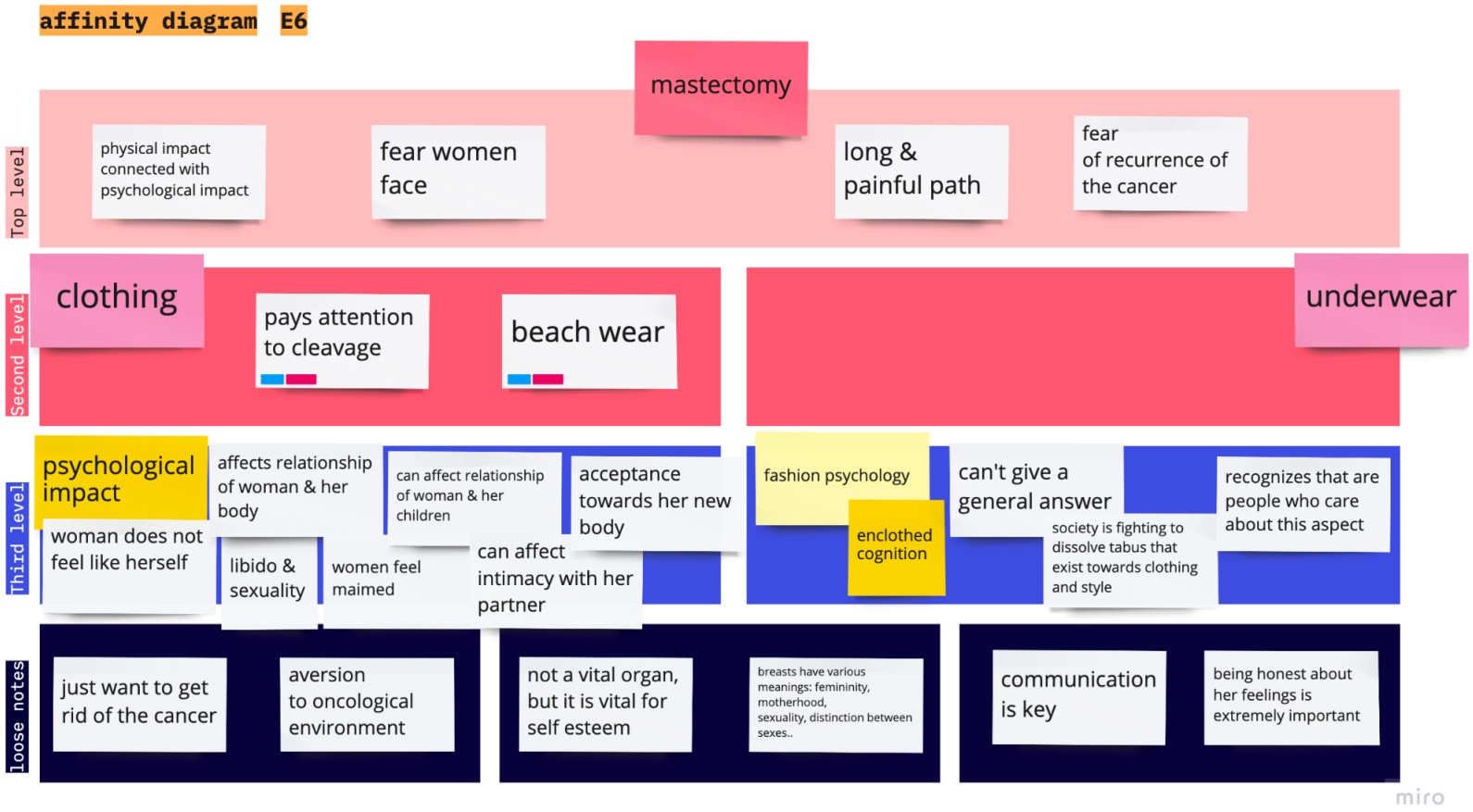



affinity diagram E2
Top level
mastectomy
chemo & radiotherapy (other treatments)
always kept the same lifestyle (active)
couldn't use bra during radiotherapy
take everything, not just the breast that had the cancer cells
looks at the mastectomy as a cure, not a bad thing
Second level
clothing
wears tops (w/ shoulder straps) but a bit more loose
wears practically everything, doesn't have a problem (prothesis)
pocket to put prothesis
although it's her size, it's very tight and marks the chest
soft & light materials (fabric
feels the need to have a good/nice bra
underwear
tight fitted bra, not comfortable
feels comfortable w/ sports bra
wants to see different options, especially for summer
practical - easy to close
Third level
psychological impact
felt constrained when not wearing the prosthesis @ gym
doesn't feel it had a big psychological impact on her
wanted to get rid of the other (eliminate chances to appear again)
the limited movements she can do, due to her arm, are the thing that it's harder for her
fashion psychology
enclothed cognition
clothing has the power to impact the persons self-esteem
not for others, it's really for herself
even colour has an impact on my self-esteem
choose clothing pieces to make me feel good
likes to get ready, choose pieces that make her feel good
feeling comfortable (movements & helping her ego)
loose notes
liked to go to chemotherapy (step closer to get rid of it)
doesn't get bothered to look @ mirror
"I feel good, happy and thankful"
bought bra & prothesis (after surgery) @ Liga Portuguesa contra o Cancro
miro


affinity diagram E3
Top level
mastectomy
radiotherapy (other treatments)
very swollen after surgery
cotton prothesis
doesn't look at the mastectomy as a bad thing
didn't hesitate to ask for the mastectomy
Second level
clothing
stopped wearing some types of more revealing cleavage
harder to wear + tight and elastic pieces of clothing
pays attention to cleavage
harder to wear tops with lace on top (didn't had a bra to support)
improvised on clothing (e.g. sewing cleavages)
found strategies
sew shoulder pads @ biquinis
sometimes wears underwire
after surgery, wore a 'sports' bra w/ zip on front
hard to find bras after surgery (prothesis)
takes into consideration the aesthetic function
with or without straps
underwear
not beautiful options
colours, designs, variety of models
hardly doesn't wear a bra
Third level
psychological impact
hard looking @ the mirror
started to get used to the situation and became easier
started to get to know some workers that she felt comfortable to share her situation
not very hard mentally
one of the hardest things was to be dependent when it came to driving
hard to go to the store and ask for help (only went to store when certain workers were there)
fashion psychology
enclothed cognition
clothing has the power to impact the persons self-esteem
even colour has an impact on my self-esteem
it's an investment on her & her self-esteem
choose clothing pieces to make me feel good
still looks for elegant and beautiful options
loose notes
since she already was a mother and was able to breastfeed her daughter, was a little bit more easier mentally
indication to go to LPCC to get a bra and prothesis
miro


affinity diagram E4
Top level
Second level
Third level
loose notes
mastectomy
loss of a very important area for women
various surgeries
scaring
radiotherapy & chemotherapy
long & painful path
very sensitive area (not only skin)
easily in contact with costal grid
don't have a lot of skin tissue there (to protect)
some muscles are removed
clothing
stopped wearing some types of more revealing cleavage
pays attention to cleavage
avoid tight fitting clothing
bra with support for prothesis & without underwire
comfortable fabric, usually cotton
lace is not a very good option (not very comfortable & doesn't provide a lot of support
not a lot of options and variety of models
underwear
needs to feel safe when using a bra
bra that doesn't inhibit to use certain clothes
options aren't affordable for everyone
lace can be considered a more sexy & beautiful option
bra with multi positions could be a good option
psychological impact
libido & sexuality
building a new self image and self concept
going to the store after mastectomy is hard (expose the condition)
fashion psychology
enclothed cognition
mental state can be perceived through clothing
people care a lot about clothes
fashion/clothing affects mental state, energy and attitude towards life
feeling of inferiority
feel like 'less of a woman'
negative affected self-esteem & self-concept
depressions
family support is crucial
courage to do breast reconstructive surgery
not a lot of investment from the fashion industry
miro


affinity diagram E5
Top level
mastectomy
physical impact depends on the age
fear women face
fear of recurrence of the cancer
scaring
long & painful path
reconstruction with tissues
reconstruction with prothesis
fibrosis on skin (painful)
Second level
clothing
pays attention to cleavage
caution with colours (so it doesn't transfer to skin)
caution with seams
caution with synthetic fibers
bra with support for prothesis & without underwire
bra straps width, at least, 2 cm
good strap size (width) to support the prothesis & don't cause harm on shoulders
underwear
lace is not a good option (it's synthetic & doesn't provide a lot of support)
bras with a 'taller' cleavage is a good option for women that have scars in the sternum or dots in that area from radio
quality of the material
size of cups accordingly with the natural breast
start by using a sports bra (practical & comfortable)
bra that opens in the front is a good option (for prothesis & practical)
Third level
psychological impact
woman does not feel like herself
it is missing something
'people don't look at me in the same way' (especially partner)
cannot get dressed (clothes don't fit properly)
libido & sexuality
fashion psychology
enclothed cognition
can't really respond to this
depends a lot on the person
loose notes
aversion to oncological environment
just want to get rid of the cancer
miro


affinity diagram E6
Top level
mastectomy
physical impact connected with psychological impact
fear women face
long & painful path
fear of recurrence of the cancer
Second level
clothing
pays attention to cleavage
beach wear
underwear
Third level
psychological impact
affects relationship of woman & her body
can affect relationship of woman & her children
acceptance towards her new body
woman does not feel like herself
libido & sexuality
women feel maimed
can affect intimacy with her partner
fashion psychology
enclothed cognition
can't give a general answer
society is fighting to dissolve tabus that exist towards clothing and style
recognizes that are people who care about this aspect
loose notes
just want to get rid of the cancer
aversion to oncological environment
not a vital organ, but it is vital for self esteem
breasts have various meanings: femininity, motherhood, sexuality, distinction between sexes..
communication is key
being honest about her feelings is extremely important
miro

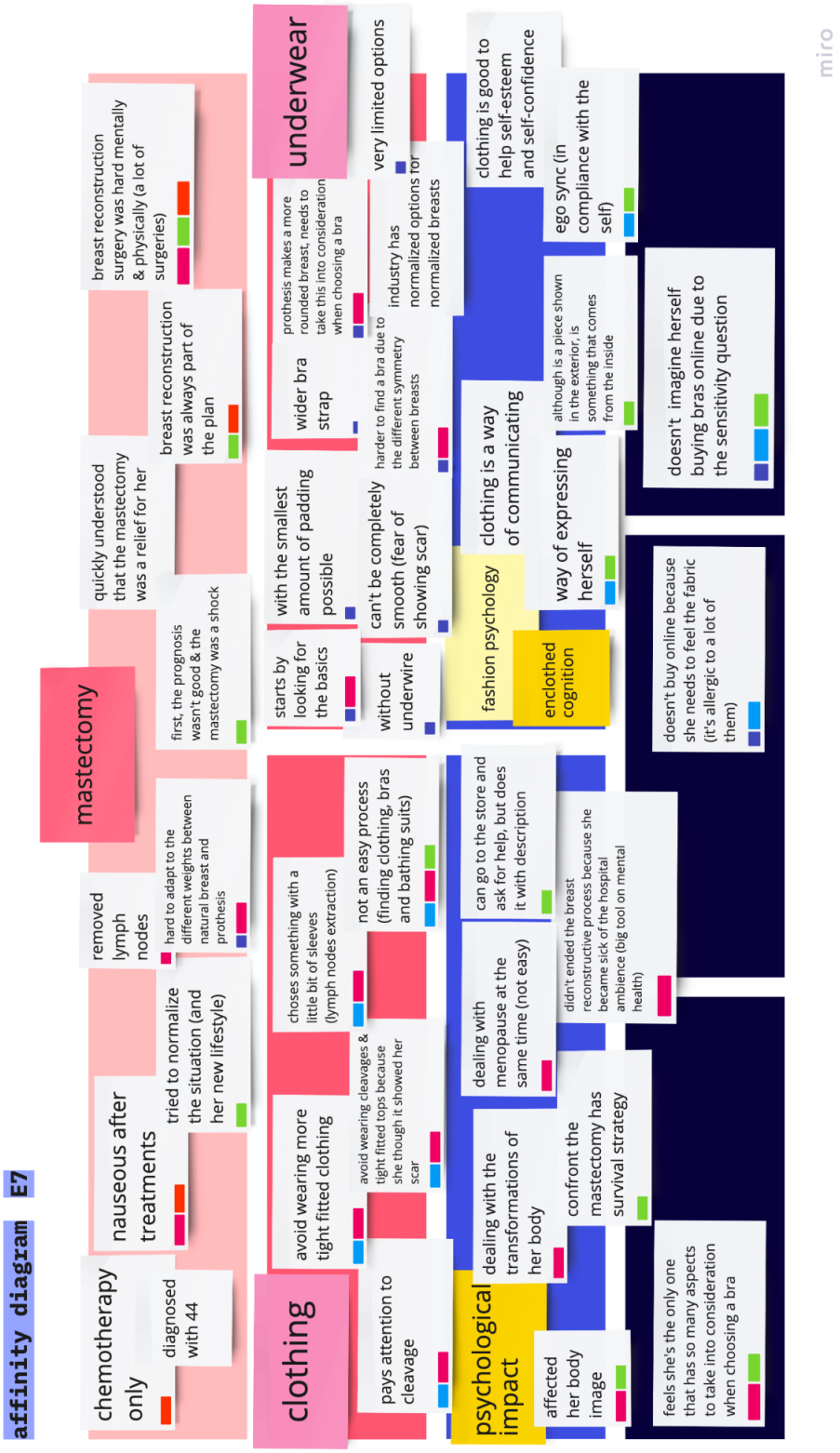


Figure 75 - Participants' affinity diagram[32]

[32] Link to affinity diagrams

Annex 6 - Presentation used in the photo elicitation activity

ELICITAÇÃO DE FOTOS

ATIVIDADE DE CO-DESIGN INSERIDA NO PROJETO DE DISSERTAÇÃO

"**ADAPTIVE FASHION AND DIGITAL TECHNOLOGIES IN POST MASTECTOMY :**
UNDERGARMENT PERSONALIZATION AS A WAY OF EMPOWERING WOMEN"

1.

ELICITAÇÃO DE FOTOS

A atividade de **elicitação de fotos** consiste em recorrer a **fotografias**, ou outros **meios visuais** para gerar **discussão**, **partilha** de **experiências** e **sentimentos**, relativos a uma determinada **temática**.

2.

OBJECTIVOS

- Promover a **comunicação** e **partilha** com os participantes
- Recorrer às **fotografias** como **guias** e **incentivos** à **conversação** e **partilha de experiências**, **sentimentos** e **pensamentos** relativos à **mastectomia** e as **opções de soutiens** existentes
- Explorar **pensamentos e sentimentos** que sejam **despoletados** pelas **fotografias** apresentadas, tal como perceber como é que as mesmas **fotografias podem representar** as **experiências particulares** de cada mulher

3.

TEMÁTICAS

- **cancro** da mama
- **imagem corporal**
- ***soutiens*** (antes e pós mastectomia)
- **maternidade** e **amamentação**
- **impacto psicológico**

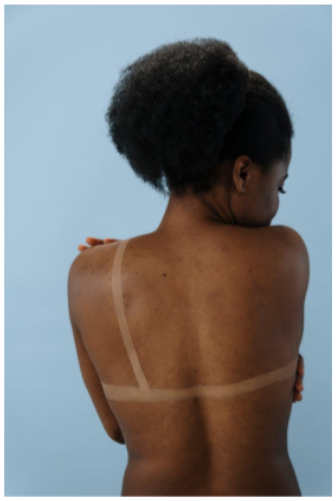
4.

FOTOS

a.

CANCRO DA MAMA

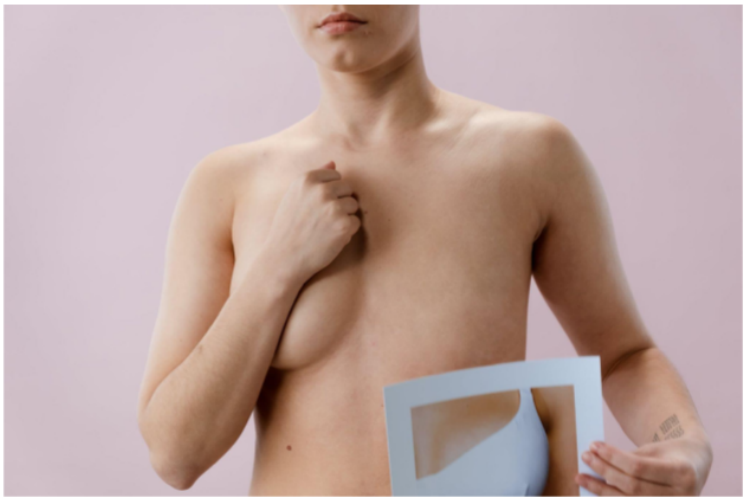
experiência pessoal



b.

CANCRO DA MAMA

impacto psicológico e na imagem corporal



c.

SOUTIENS
(antes e pós mastectomia)

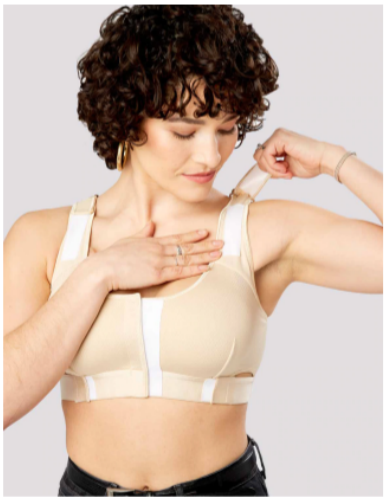


Figure 76 - Slides for the Photo Elicitation activity

Annex 7 - First tests for the logotype

Figure 77 - Test one for the logotype

Figure 78 - Test two for the logotype

Figure 79 - Test three for the logotype

Annex 8 - Low fidelity prototypes conducted before achieving the final ones

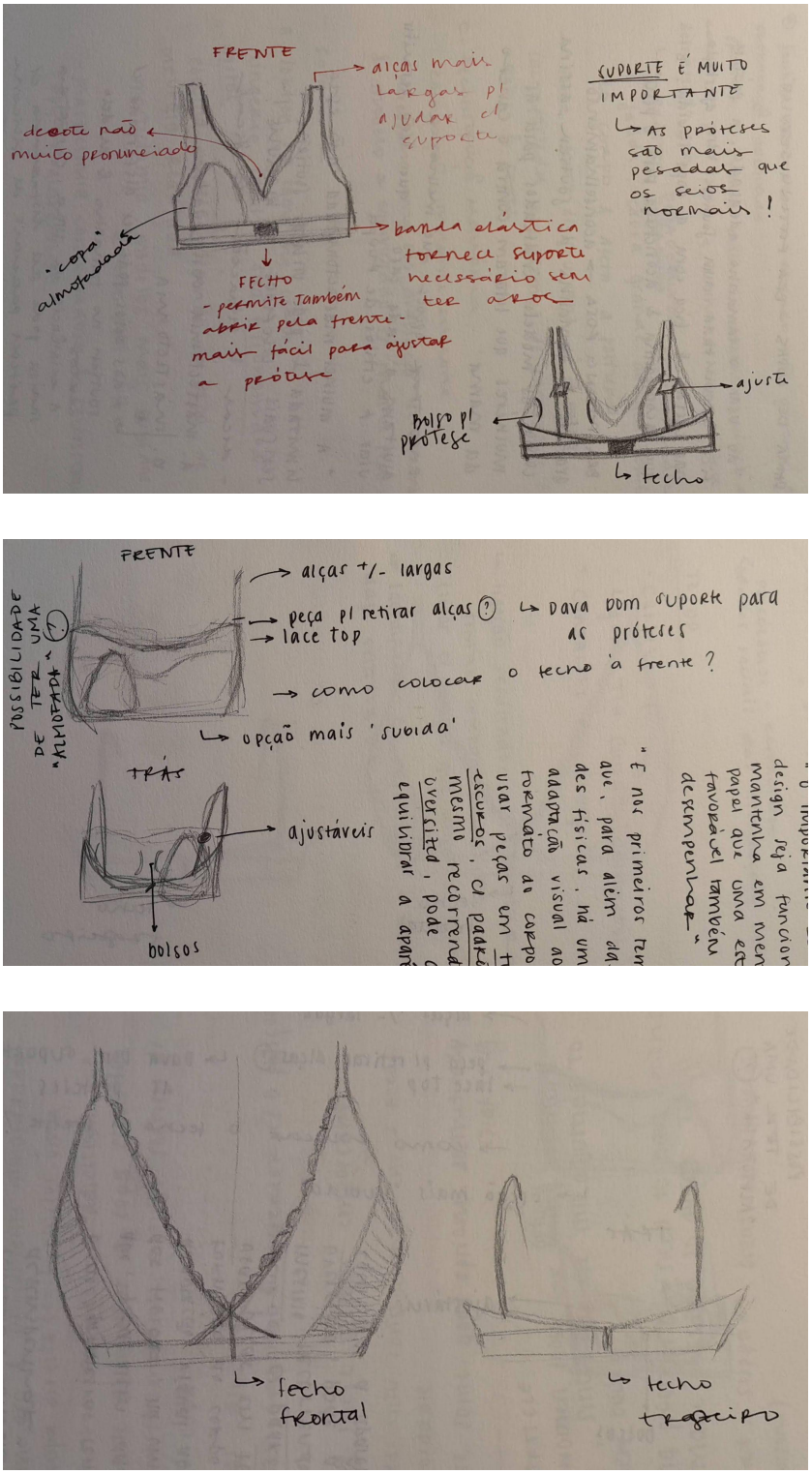
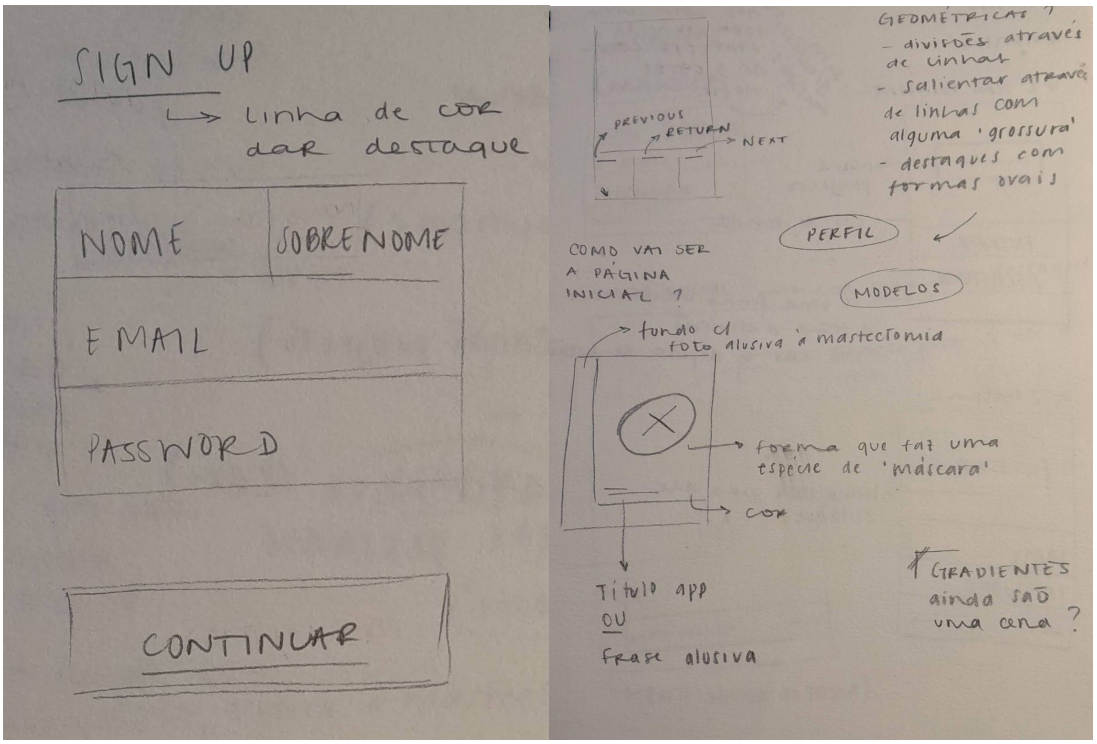
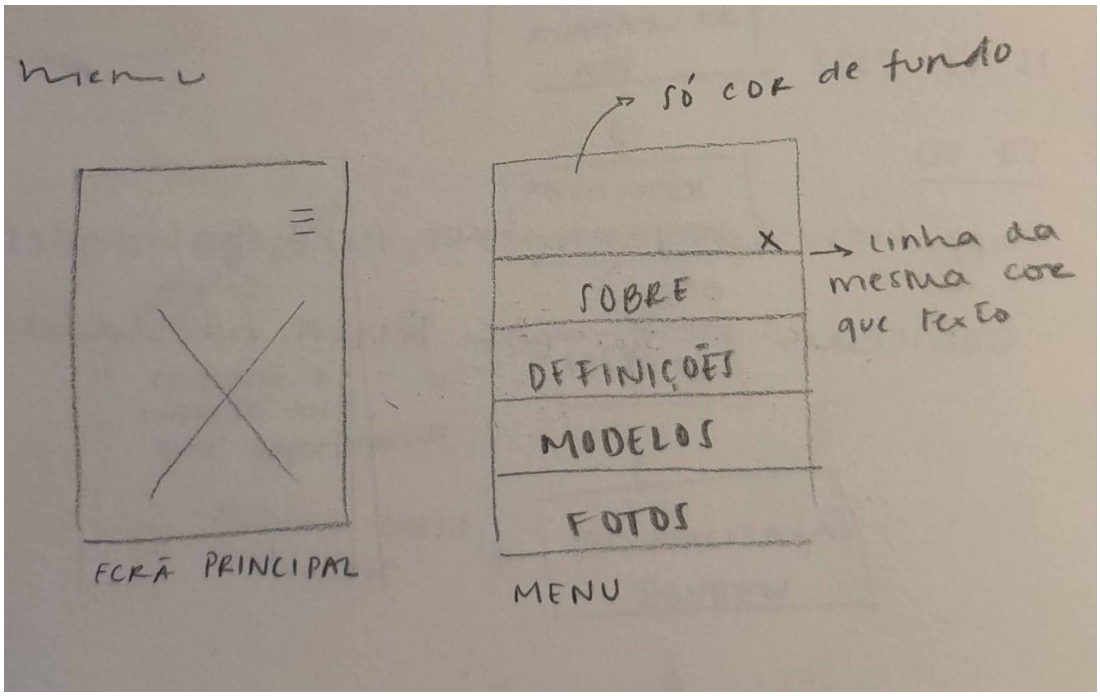


Figure 80 - First paper prototypes for the bra model


SIGN UP
↳ linha de cor dar destaque
NOME
SOBRENOME
EMAIL
PASSWORD
CONTINUAR
PREVIOUS
RETURN
NEXT
GEOMÉTRICAS ?
- divisões através de linhas
- salientar através de linhas com alguma 'grossura'
- destaques com formas ovais
PERFIL
MODELOS
COMO VAI SER A PÁGINA INICIAL ?
fundo cl foto alusiva à mastectomia
forma que faz uma espécie de 'máscara'
cor
Título app
OU
Frase alusiva
GRADIENTES ainda são uma cena ?


Menu
só cor de fundo
X
linha da mesma cor que texto
SOBRE
DEFINIÇÕES
MODELOS
FOTOS
ECRÃ PRINCIPAL
MENU

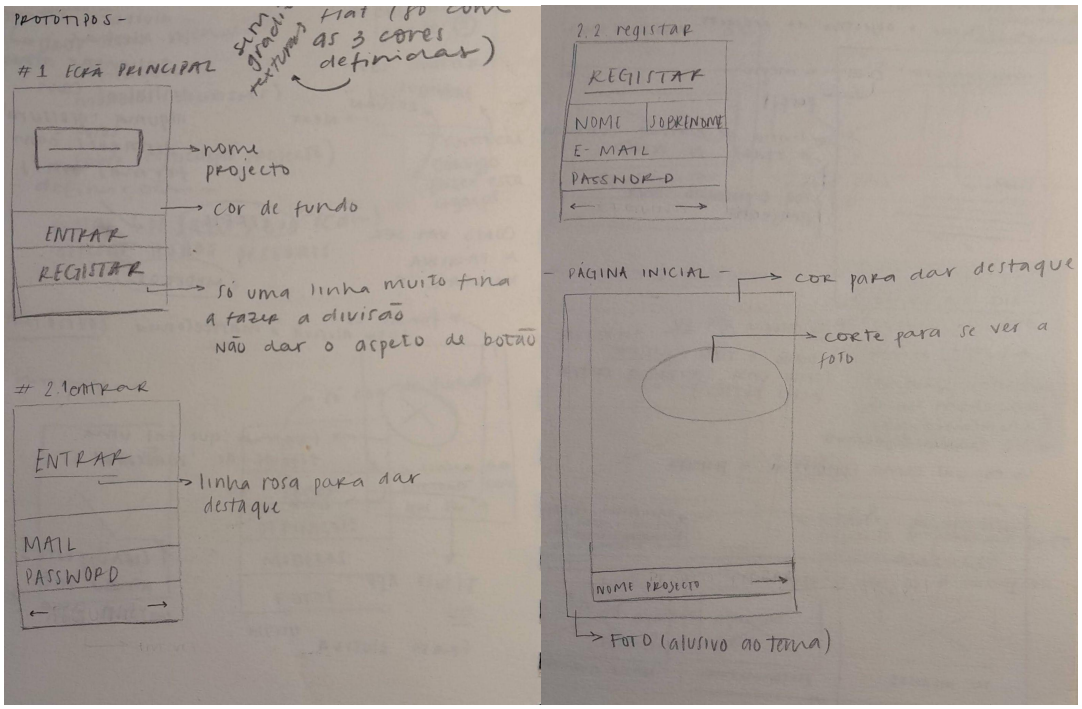


Figure 81 - First paper prototypes for the user interface layouts

Annex 9 - Final layouts for the proof of concept, prototyped in Figma

Figure 82 - Login layout

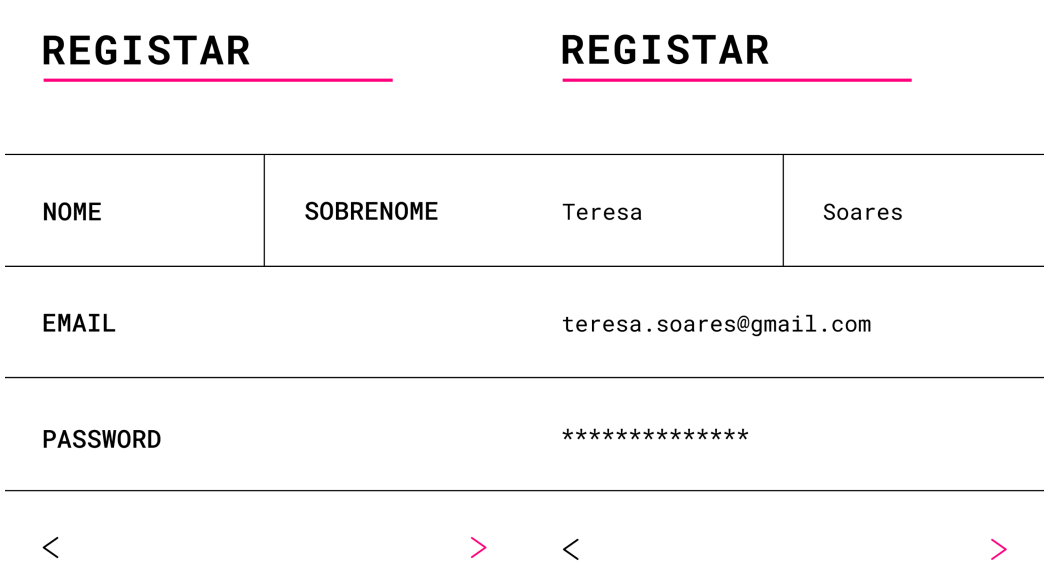


Figure 83 - Register layout

Figure 84 - Menu layout

Figure 85 - Menu - avatar layout

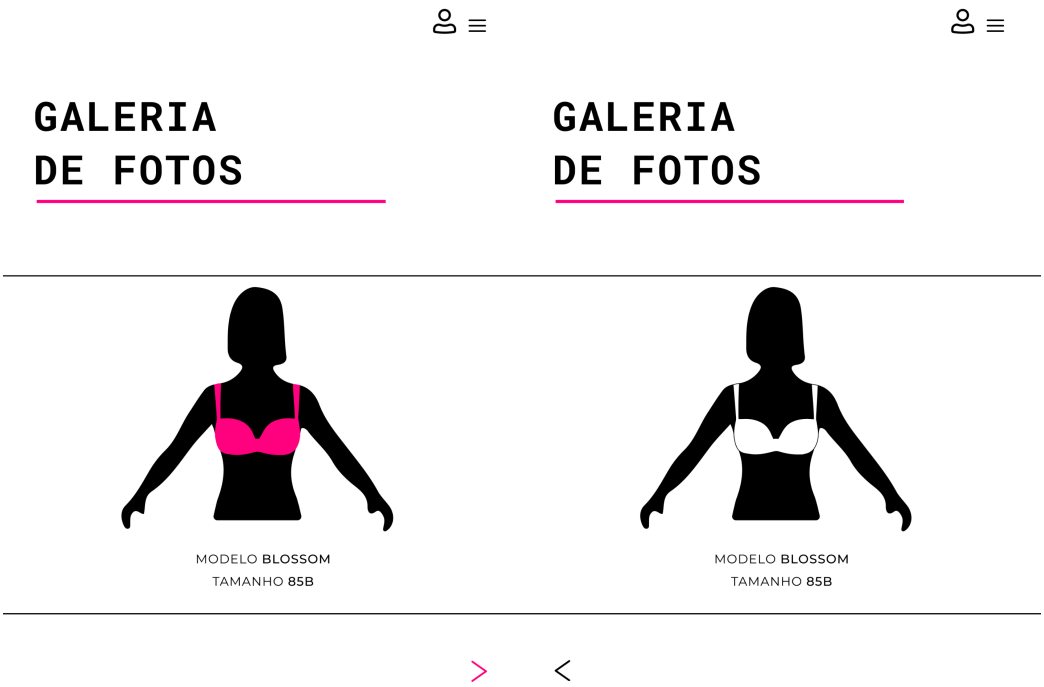


Figure 86 - Photo gallery layout

Figure 87 - About layout

COMO FUNCIONA

VÊ OS MODELOS

COMO FUNCIONA

PERSONALIZA O MODELO

COMO FUNCIONA

CRIA UM AVATAR

COMO FUNCIONA

EXPERIMENTA

Figure 88 - How it works layout

Figure 89 - Choose bra layout

Figure 90 - Find your size overlay layout

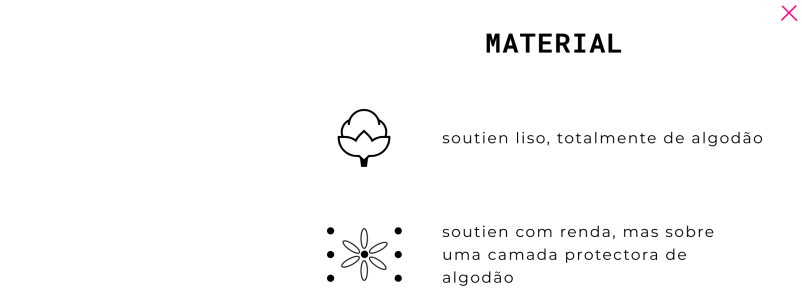


Figure 91 - Material overlay layout

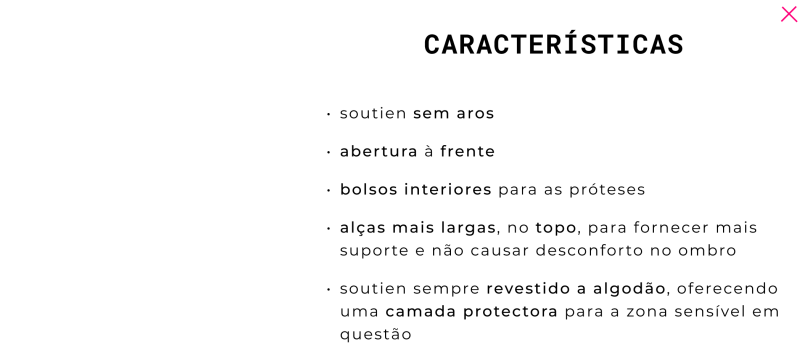
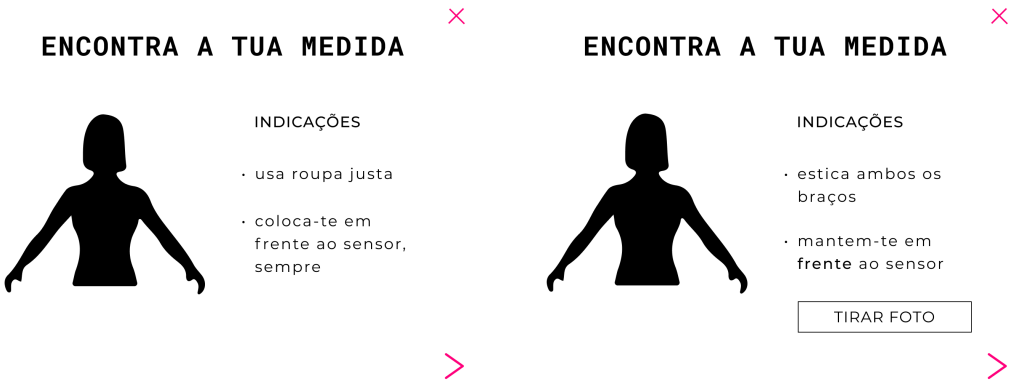


Figure 92 - Characteristics overlay layout



ENCONTRA A TUA MEDIDA

INDICAÇÕES

- roda para o teu lado **direito**, sempre de braços esticados e em frente ao sensor

TIRAR FOTO

ENCONTRA A TUA MEDIDA

INDICAÇÕES

- fica de **costas** para o sensor, com os braços esticados

TIRAR FOTO

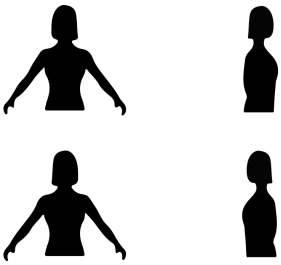
ENCONTRA A TUA MEDIDA

INDICAÇÕES

- roda agora para o teu lado **esquerdo**, com os braços esticados e em frente ao sensor

TIRAR FOTO

ENCONTRA A TUA MEDIDA



CALCULA AS TUAS MEDIDAS

A CALCULAR AS TUAS MEDIDAS...

ENCONTRA A TUA MEDIDA

AS TUAS MEDIDAS SÃO:

Busto: 80 cm

Abaixo do peito: 70 cm

O TEU TAMANHO DE SOUTIEN É:

85B

Figure 93 - Find your size layout

Figure 94 - Previous measurements overlay layout

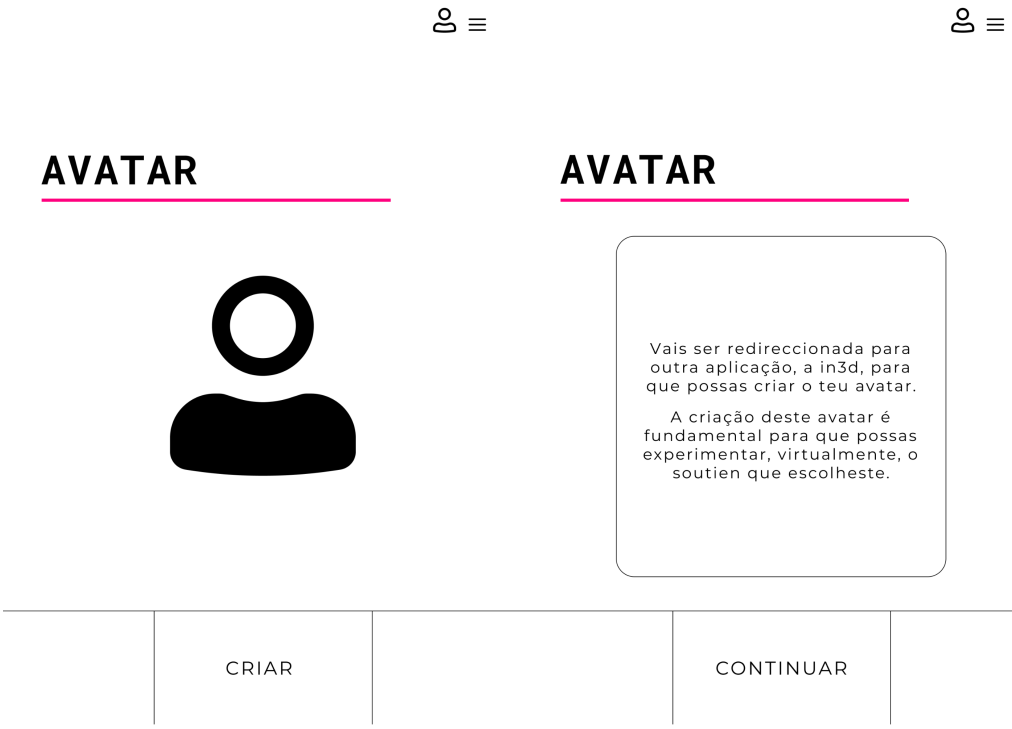


Figure 95 - Create avatar layout

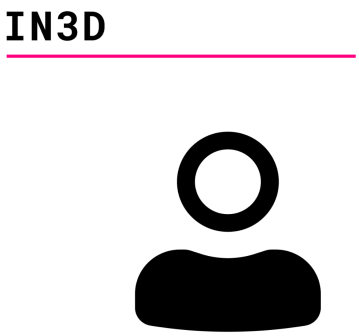


Figure 96 - Redirect to in3d layout

Figure 97 - Virtual dressing room layout

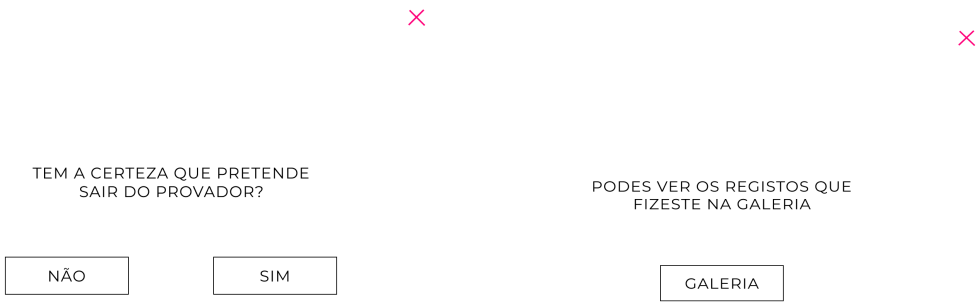


Figure 98 - Exiting warning overlay layout

Annex 10 - Different colors and materials the bra model can present

Figure 99 - Black cotton bra model

Figure 100 - Black lace bra model

Figure 101 - Pink lace bra model

Figure 102 - White lace bra model

Figure 103 - White cotton bra model

Annex 11 - Usability test script

GUIÃO TESTE DE USABILIDADE

Consentimento Informado

Perfil Sociodemográfico

Antes de começar o teste aos protótipos, pedia só que respondesse a um pequeno questionário para que eu, posteriormente, consiga fazer um perfil sociodemográfico dos participantes neste estudo.
Qual a sua idade?

☐ menos de 25 anos
☐ 25 - 35 anos
☐ 36 - 45 anos
☐ 46 - 50 anos
☐ 51 - 55 anos
☐ 56 - 60 anos
☐ 61 - 65 anos
☐ mais de 65 anos

Já foi submetida a uma mastectomia?
☐ Sim
☐ Não

Já retirou as suas próprias medidas (busto) para escolher um tamanho de soutien?
☐ Sim
☐ Não

Já comprou soutiens para pós mastectomia?
☐ Sim
☐ Não

Já fez compras online?
☐ Sim
☐ Não

No seu dia a dia, utiliza o tablet?
☐ Sim

☐ Não

Se sim, para quê?

☐ Trabalho

☐ Compras online

☐ Lazer (por exemplo, ver notícias, ler, redes sociais, etc)

☐ Outras (indicar):

Teste de usabilidade

O objectivo desta dissertação passa pelo desenvolvimento de uma prova de conceito de uma aplicação pensada para mulheres que foram submetidas a mastectomias. Através desta prova de conceito, vai ser possível experimentar virtualmente, e em casa, um soutien que é adaptado às necessidades específicas de cada mulher. Para além disso, vai ser também possível personalizar, e customizar o soutien escolhido. Para a personalização do tamanho do soutien, as medidas do peito da utilizadora vão ser retiradas, para que o modelo de soutien sirva e se ajuste da melhor maneira possível. Em termos de customização, a utilizadora poderá escolher entre cores e tecidos.
O que se pretende com este projecto é apresentar uma opção elegante e bonita, não deixando de parte o aspecto funcional que o soutien necessita de ter.

A presente atividade tem como objectivo testar os protótipos desenvolvidos com futuras utilizadoras, como é o seu caso. Para contextualizar, o protótipo é uma simulação do produto final e, neste caso, trata-se de um protótipo digital. Este protótipo foi desenvolvido de tal forma que a participante consegue interagir com o mesmo, navegando pelo protótipo, como se fosse o produto final.

Nesta fase do projecto a sua colaboração é importante, de forma a que eu seja capaz de perceber até que ponto é que os protótipos desenvolvidos dão resposta ao problema inicial, funcionando como uma solução. Sendo assim, a actividade proposta para agora denomina-se de testes de usabilidade. Nestes testes vai interagir com os protótipos, navegando entre as diferentes páginas da aplicação, completando pequenas tarefas que lhe vou indicar. Pedia, ainda, que verbalizasse o que está a pensar enquanto interage com o protótipo. Nada do que diga, ou faça, está errado.
Exploração inicial, de forma livre, da aplicação

Antes de começar as pequenas tarefas que tenho planeadas, pode explorar a aplicação de forma livre, de maneira a que se familiarize com a mesma. Convido-a então a fazer esta exploração durante 1 ou 2 minutos.

Qual é a sua primeira impressão da aplicação?

Tarefas

O objectivo agora, nesta parte do teste, é que tente concretizar 7 tarefas que pensei para este teste.

São tarefas simples, cada uma com um objectivo. Isto irá ajudar-me a perceber se consegue interagir e navegar, da melhor forma possível, com a aplicação. Desta maneira, o meu objectivo não é avaliar a sua performance, mas sim perceber se os protótipos estão a comunicar o que é pretendido.

Tarefa 1 - Ver a explicação do funcionamento da app

É a primeira vez que está a abrir a aplicação Sakura e não sabe como esta funciona, só sabe que a irá ajudar a experimentar, virtualmente e em casa, soutiens que foram desenhados e pensados para si. Desta forma, a primeira tarefa do teste passa por perceber o âmbito da aplicação e o seu funcionamento.

Tarefa 2 - Registar-se na app

Agora que já percebeu o âmbito e funcionamento da aplicação Sakura, pode, por favor, criar uma conta para poder começar a usar a aplicação.

Medidas a recolher: Tempo de realização da tarefa; Nº de toques no ecrã; Nº de erros; Conclusão da tarefa.

Tempo de realização da tarefa:
Nº de toques no ecrã:
Nº de erros:
Conclusão da tarefa:

Tarefa 3 - Escolher o soutien
Agora que já se registou e entrou na aplicação, quer ver que modelos de soutiens estão disponíveis e, depois, escolher um modelo.

Medidas a recolher: Tempo de realização da tarefa; Nº de toques no ecrã; Nº de erros; Conclusão da tarefa.

Tempo de realização da tarefa:
Nº de toques no ecrã:
Nº de erros:
Conclusão da tarefa:

Tarefa 4 - Personalizar soutien e tirar medidas
Depois de escolher o soutien, quer agora personalizá-lo?
Nesta parte da aplicação, vai conseguir tirar as suas medidas e saber qual o seu tamanho de soutien ideal.
Além disso, leia as opções de material existentes e altere a cor e o material do soutien que escolher.

<u>Questões:</u>

- Achou esta funcionalidade pertinente?

- Existe alguma coisa que não tenha percebido?
- Tem alguma sugestão de melhoria?

Medidas a recolher: Tempo de realização da tarefa; Nº de toques no ecrã; Nº de erros; Conclusão da tarefa.

Tempo de realização da tarefa:
Nº de toques no ecrã:
Nº de erros:
Conclusão da tarefa:

Tarefa 5 - Criar Avatar
Para conseguir experimentar o modelo de soutien que já seleccionou e personalizou, precisa de primeiro criar um avatar.
Este avatar é um modelo 3D do seu corpo e que vai permitir que experimente o soutien de forma virtual. Pode criar esse avatar?

Questões:
- Achou esta funcionalidade pertinente?
- Existe alguma coisa que não tenha percebido?
- Tem alguma sugestão de melhoria?

Medidas a recolher: Tempo de realização da tarefa; Nº de toques no ecrã; Nº de erros; Conclusão da tarefa.

Tempo de realização da tarefa:
Nº de toques no ecrã:
Nº de erros:
Conclusão da tarefa:

Tarefa 6 - Provador virtual (experimentar)
Agora que já escolheu o soutien e criou um avatar, já pode experimentar o modelo seleccionado no seu provador virtual. Pode então experimentar virtualmente o modelo de soutien que escolheu? Para além disso, pedia que tirasse uma fotografia do seu avatar com o modelo de soutien escolhido.

Questões:
- Achou esta funcionalidade pertinente?
- Existe alguma coisa que não tenha percebido?
- Tem alguma sugestão de melhoria?

Medidas a recolher: Tempo de realização da tarefa; Nº de toques no ecrã; Nº de erros; Conclusão da tarefa.

Tempo de realização da tarefa:

Nº de toques no ecrã:
Nº de erros:
Conclusão da tarefa:

Cenário 7 - Sair do provador e ir à galeria de fotos
Depois de ter experimentado, virtualmente, o soutien quer sair do provador virtual. Enquanto experimentava o soutien, tirou uma fotografia para poder ver sempre como é que o modelo fica. Saia do provador virtual e vá à galeria de fotos para ver novamente como o soutien lhe ficou.

- Achou esta funcionalidade pertinente?
- Existe alguma coisa que não tenha percebido?
- Tem alguma sugestão de melhoria?

Medidas a recolher: Tempo de realização da tarefa; Nº de toques no ecrã; Nº de erros; Conclusão da tarefa.

Tempo de realização da tarefa:
Nº de toques no ecrã:
Nº de erros:
Conclusão da tarefa:

Questões abertas - Pós teste
Depois de ter concluído os cenários que propus, e ter explorado mais a fundo a aplicação e as suas funcionalidades, tenho agora algumas perguntas que gostaria de lhe fazer. São perguntas sobre aspectos funcionais e de design da aplicação, que quero perceber se são apresentados da melhor forma.

1. Sentiu falta de uma opção no menu que a redirecciona-se para a explicação do funcionamento da aplicação?
2. Achou a aplicação interessante no que toca a aquisição de soutiens adaptados às necessidades de pós mastectomia?
3. Utilizaria esta aplicação para escolher soutiens? Pode, por favor, justificar a sua resposta?
4. Em relação ao **sistema de tamanhos** utilizado, e à forma como as medidas podiam, eventualmente, ser retiradas, acho que este era fidedigno? Não se sentiu confusa com a informação? Ou acho que era muita coisa para assimilar?
5. No geral, o que achou da aplicação? (Aqui pode falar do que quiser, conceito, layout, cores, tipografia, etc.)

System Usability Scale
Nesta parte do teste de usabilidade, vou pedir-lhe que avalie as seguintes afirmações, recorrendo a uma escala entre 1 e 5, sendo 1 discordo totalmente e 5 concordo totalmente.

	1	2	3	4	5

1. Acho que gostaria de utilizar este sistema com frequência					
2. Considerei o produto desnecessariamente complexo					
3. Achei que o sistema era fácil de utilizar					
4. Achei que necessitaria de ajuda de um técnico para conseguir utilizar este sistema					
5. Considerei que as diversas funcionalidades deste sistema estavam bem integradas					
6. Achei que este sistema tinha muitas inconsistências					
7. Suponho que a maioria das pessoas aprenderia a utilizar este sistema rapidamente					
8. Considerei o sistema muito complicado de utilizar					
9. Senti-me muito confiante ao usar este sistema					
10. Precisei de aprender muitas coisas antes de conseguir utilizar este sistema					

Net Promoter Score (NPS)

Numa escala de 0 a 10, qual é a probabilidade de recomendar esta aplicação a uma mulher que tenha sido submetida a uma mastectomia?

0 1 2 3 4 5 6 7 8 9 10