

This exegesis is submitted to the

**Auckland
University of Technology**

in partial fulfilment of the degree

of

Master of Arts
(Art and Design)

2005

Lize Niemczyk

The Analysis, Design and Evaluation of an Unstructured Bra

Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a university or other institution of higher learning, except where due acknowledgement is made in the acknowledgements.

Acknowledgements

The designer would like to take this opportunity to express her gratitude to some of the people who were involved in this project.

First of all, she owes thanks to Leong Yap for being the overall supervisor. She would like to thank Sam Hawke for the fruitful discussions and useful advice with regard to patent and copyright laws. A thank you is due to Dr Belinda Scott for being involved in the information gathering. Thanks to Elizabeth Arden for editing this exegesis: and a special thanks goes to Luca Lo Sicco for his input and backing. Big thanks go to Swarovski for their assistance and help in completing the bra designs.

On a more personal note, the designer would like to mention some people who mean a lot to her. First of all, her husband, Jideck Niemczyk, who provided ongoing support. Without his support I would not have completed this exegesis. Thanks go to my friends, in particular Annette Gebbie and Mark Peddie and family who were always there for me – especially whenever I needed encouragement and support to complete this task. Last but by no means least, I would like to thank Urszula Niemczyk, my daughter, for understanding and being accepting of the time and dedication required for this exegesis.

Table of Contents

Attestation of Authorship.....	5
Acknowledgements.....	7
Abstract.....	11
Introduction	13
Glossary.....	17
Chapter 1 -Literature and Historical Review.....	21
Early Bras	22
Bra Times	24
Modern Bra Years	26
Sizing.....	28
Some Health Issues To Do with Bra Wear	32
Chapter 2 -Background of the Project	39
Chapter 3 -Methodology	45
Chapter 4 -Design Criteria and Development	51
Chapter 5 -Design Process	55
Mary Tucek - 1893	61
Mary Phelps - 1914.....	71
Arthur Garson - 1962	81
The Cone-Shaped Bra: 1937 -Big is Good!	87
Wonderbra - 1964	95
Bioform Bra - 2002	99
Chapter 6 -Design and Development of the “Octi” Bra.	105
Chapter 7 -Evaluation	117
Chapter 8 -Conclusion	127
References	129
Internet Websites -Bibliography:	134
Table of Figures.....	139
Endnotes	145

Abstract

This practice-based research focuses on the analysis, design and evaluation of an unstructured push-up plunge bra, which combines technical know-how with the sensitivity of bra wearers. The goal of such a dual combination was to create an easily wearable, yet extremely comfortable, fashionable and health-conscious bra. Current bra designs do not contribute to the well-being of the wearer and employ devices that substantially constrict the breasts with unhealthy results.

The proposed exegesis introduces a new prototype bra based on new concepts and new construction techniques inspired by old bra patents, and on the latest design information captured from a variety of technological, material and process information. This exegesis documents an historical overview of bra design and the conceptualisation, design, prototyping and evaluation of six significant bra concepts.

This project consists of an exhibition of practical work that represents the main body of applied research. The practical work constitutes 80% and the exegesis consists of 20% of the project's value.

Introduction

This exegesis is concerned with an unstructured push-up plunge bra prototype and is not about fashion in general. It collates previous achievements in bra designs and designers' intrinsic knowledge of fashion development into a workable formula for the creation of a new product. This thesis is concerned with the creation of an innovative bra and therefore relates to breasts: *"Breasts that are an essential quality of all that is female: ageless symbols that have represented female sexuality and motherhood throughout history. Serving purpose and desire, the bra is conceivably the most influential factor of a woman's attire. What other piece of wear inspires such affection, longing, wonder, irritation and enchantment."*ⁱ (Beatrice Fontanel, 1992).

In general, bra-like garments have been around for over 4500 years. They have evolved from a single band around the breasts to complicated designs such as the Wonderbra, Bioform Bra, Miracle Bra, X-Bra and finally this project's unstructured push-up plunge bra.

The designer seeks, through this exegesis, to respond to the female spirit of creative self-expression by making a new push-up plunge bra that has no structural elements - (under-bust wiring, padding, boning, etc.), and to develop state-of-the-art construction and technology for contemporary lingerie designs. The designer's focus is to design a bra that allows for the simultaneous comfort, fashion needs and well-being of the wearer. The designer has chosen to implement these concepts by making use of factors such as aesthetics, fashion construction and health issues as they relate to six existing individual designs that were considered in this project.

The designer is not the first person to attempt to create a comfortable bra. In fact, there have been hundreds of attempts at designing a bra garment that provides some breast support. In the past, designers succeeded “*not in designing an ideal bra but in creating bra-fashion-marketplace awareness that it may seem grew naturally out of their labours*”ⁱⁱ (Chafe, 1972).

The vision of a performance bra that offers comfort, fashion and well-being has a long history, as records of the garment’s evolution suggest. In this project the designer hopes to add to this history a challenging new design and provide simplicity, innovation and originality in a series of new bra garments.

The collection of practical work has been made possible through the analysis and exploration of historical patents, material development, material processes and technical know-how, and imagination.

The prototypes that the designer has developed and evaluated have been met with users’ enthusiasm, which points to the robustness of the research method, technical know-how and conceptual innovation used in the project.

Glossary

Anthropometry -the branch of the human sciences that deals with body measurements.

Bias -cross grain of a fabric.

Bra or brassiere -a shaped undergarment worn by women to mould and support the breasts. Usually consists of two cups held in place with straps over the shoulders and elastic at the back

Bones -narrow, flexible strips of whalebone, steel, feather quills or plastic used to stiffen and shape foundation garments.

Bust -the chest of a woman.

Bust point -nipple, areola.

Cleavage -the partial exposure of the breasts. Extreme cleavage may also lead toward areolage, the partial revelation of the areola, and in the extreme to nippage, the exposure of the nipple.

Corset -a tightly fitted, boned two-piece garment that shapes the torso; usually closed with a front busk and back lacing.

Demi cups -the fabric triangle of the bra that covers the breast, designed proportionate to half a full cup, the demi typically runs straight across the breast just above the nipple and has a low centerfront.

Diagrammatic -a technical drawing or diagram.

Lingerie -relates to decorative, attractive, women's underwear.

Lymphatic system -the tissues and organs that produce, store and carry white blood cells that fight infection and disease. This system includes the bone marrow, spleen, thymus, and lymph nodes and a network of thin tubes that carry lymph and white blood cells. These tubes branch, like blood vessels, into all the tissues of the body.

Mannequin -a three-dimensional representation of the human form, somewhat idealized and stylized, used to exhibit wearing apparel. Mannequins may be realistic in interpretation, semirealistic or abstract. Mannequins will vary in sizes and proportions depending upon type, age group, manufacturer and current fashion look.

Ouch zone -an area under the arms where the wire pinches the flesh.

Overlay -the upper layer of an overlay technique. The layer with the design.

Plunge bra -a bra that reveals part of the bosom through V-cut.

Polypropylene -a tough, lightweight, rigid plastic made by the polymerisation of propylene gas

Push-up bra -a brassiere designed to support and emphasize the breasts in a prominent position. They frequently have padding, boning, underwires or other mechanical augmentations.

Ptotic -abnormal lowering or drooping of an organ or a body part because of muscle weakness or paralysis.

Silhouette -a dark image outlined against a lighter background.

Silicone -a synthetic gel that is used as an outer coating on breast implants and as the inside filling of some implants.

Soft cup -a bra cup made of a soft and lightweight material.

Strapless bra -a brassiere held in place without shoulder straps. These frequently contain underwires, boning, elastic or a combination of these.

Stitching -joining pieces of fabric or attaching by stitches.

Toile -a garment made up in muslin or calico to show how a design will look before cutting the fabric; a muslin or calico copy of a garment.

Underwire -a U-shaped plastic or metal strip sewn into a channel under the cup of the brassiere to add support, shaping features or rigidity to the garment.

Chapter 1 -Literature and Historical Review

The significant amount of historical bra design information forming the core of this project provided the researcher with a source for an inquiry into major bra designs and for creating parameters for a new bra creation.

Past and current literature has indicated that both males and females are fascinated and obsessed with breasts. Desmond Morris argued that buttocks were most likely early humans' principal sexual indicator, drawing interest to the genitals and promoting rear contact in our pre-bipedal daysⁱⁱⁱ Once our ancestors started standing, our breasts advanced to imitate our buttocks.^{iv} Breasts are this projects's focal point.

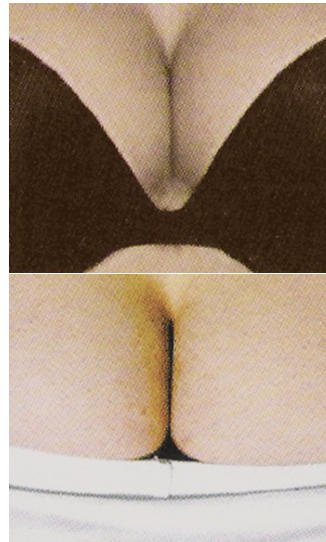


Figure 1: Cleavage (*top*) and buttocks (*below*)

Cleavage is important to a woman's sense of beauty, and current fashion accentuates the breast area as never before.

The bra garment, variably known as the brassiere, has a history that spans several centuries of work by many gifted fashion practitioners.

While this may not be recognized by many female bra wearers of today, there is very strong evidence of the influence of the old patented bra designs in today's bra creations.

The following is a brief review of brassiere developments and the key influences that they have imposed on women, fashion at different times and society generally.

Early Bras

The earliest known device that could be classified as a bra was used as early as 2500 BC, to enhance the female figure. Women wore garments that lifted the bare breasts out of their clothing to enhance their bosom. The designer believes that this garment should be considered to be the first push-up bra.



Figure 2: Cretan woman's bra 2500BC

Greek and Roman women wore breast bands to flatten and therefore minimise their breasts. The purpose was not to make the breasts prominent but to hold them firmly in place and prevent them from bouncing while a woman walked or ran.



Figure 3: Roman athletes wearing bra bands

Over the following centuries female breasts were enhanced either by flattening or spreading out the bust lines, depending on what was fashionable at the time, and utilising the range of technologies and materials available at that time.

The Renaissance period brought the introduction of the first *brassiere/corsets* by Catherine de Medici the wife of the King Henri II of France who enforced a ban on "thick waists".



Figure 4: Catherine de Medici

It is widely known now that corsets squashed the breasts (the breasts actually swelled out from the pressure of the corset), constricted the torso, compressed the lungs and interfered with digestion and childbearing. As early as 1857, books were published on the dangers of wearing corsets.^v

The age of the French Revolution and Napoleonic Wars began with the waistline raised and the accent placed on the bosom. Main apparel was influenced by the Neo-classical movement in art, which inspired the Grecian statuesque lines of women's silhouettes. Rounded breasts and figures were considered the ultimate: *"The fashion of dressing is to appear 'prominent' and accordingly 'false bosoms' of wadding, also affectionately known as 'bosom friends' were employed by the less well endowed. (The Times, 1793)"*^{vi}.



Figure 5: Napoleonic fashion

Bra Times

In the nineteenth century the hold of the corset over the domain of undergarment manufacturing was broken. It happened when a bra-like contraption that gave a *symmetrical rotundity* to the breasts was patented in 1859 by Henry S. Leshner of Brooklyn, New York. Although it is recognisably a bra, the design looks uncomfortable by current standards.^{vii}

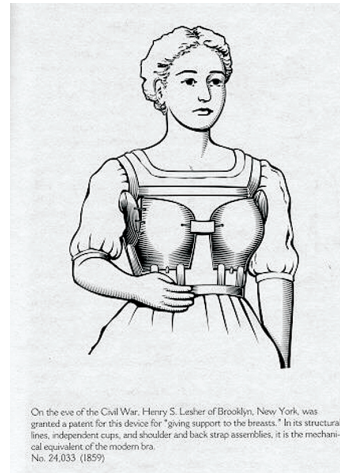


Figure 6: Henry S. Leshner's first bra patent

Luman Chapman patented the second bra-like garment in 1863. This design was introduced as a corset replacement, it had “breast puffs” and “elastic shoulder brace straps” to reduce the “friction” of the breasts.^{viii} The product made a huge splash, because -unlike the corset -its straps let a woman’s shoulders support the weight of the breasts. Although many years were still to pass before the real *brassiere* emerged. Chapman’s patent was really the first step in the direction of modern bra design.

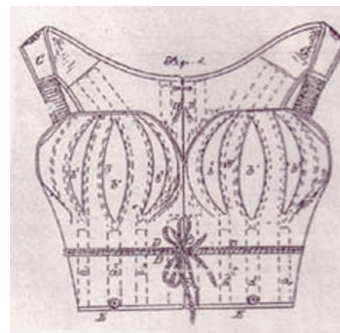


Figure 7: Luman Chapman's patent

His patent was like a beacon for the undergarment designers as it pointed them in the right direction for the further development of an entirely new form – a breast-supporting bra.^{ix} To paraphrase Brigit Keenan of the *Daily Express*:

“Suddenly someone had invented a garment which we realised we had been waiting for ages. It gave anyone wearing it a sense of identity with themselves, their youth and freedom from bondage.” (Keenan,^x 2000)

While these innovators developed the precursors of today's bras, other pioneers developed new fabrics (lycra, Dupont, 1960) and technological processes (whirlpool stitching, 1930, seamless sewing, 1970) that would revolutionise the fashion industry.

Modern Bra Years

1920 – 1937 -Flapper Bra.

Fashion echoed the mood of the era. For women a curvy shape was no longer de rigueur; breasts, hips, bottoms were out – angles were in.

A new type of underwear was required. Bras were designed to stop above the waist. Under dresses flappers wore a cylindrical one-piece, with suspenders. These flattened the breasts and hips and smoothed the waist. Flappers were young, most had smallish, firm breasts, untested by maturity, pregnancy, breast-feeding, or gravity. Bandeaux style bras were popular as this bra flattened women's breasts



Figure 8: 1920's flat chest fashions

1937 – 1957 - Cone-Shaped Bra.

Clothes worn by Hollywood stars had a huge impact on fashion. This period introduced the first padded bra, the cone-shaped cups giving the perfect Sweater Girl look.

The first underwear boutiques cashed in on the female desire to emulate the glamorous world of Hollywood stars: Lana Turner, Ava Gardner, Rita Hayworth and Jane Russell to name a few.



Figure 9: Jane Russell in *The Outlaw*

1960 – 1999 –The “All About Enhancing What Women Had” Years

The Wonderbra was designed in 1964. However it did not make significant inroads into fashion until 1992. Suddenly everyone wanted cleavage and Wonderbra was the way to get it. Fashion called for bras that created firm, naturally shaped breasts that complemented the muscular physiques of the age as influenced by Jane Fonda’s fitness videos. During the ’90s the outrageous bra designs that Madonna wore on the Blonde Ambition tour caused a new focus in bra wear; it was okay to wear underwear as outerwear.^{xi}

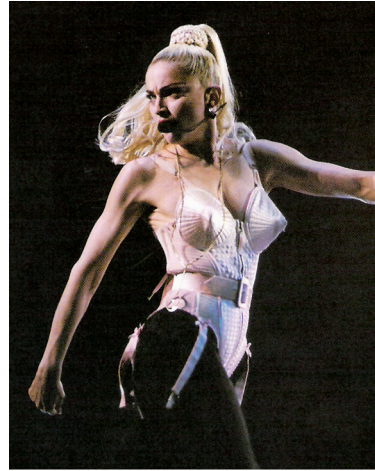


Figure 10: Madonna wearing the “bullet bra”

This historical review of bra design and development through the ages gives much food for thought and inspiration.

The link between the fashion of the day, the technology, materials and manufacturing processes seem significant. The designer was so impressed with some of the historical patents that she has selected four of them to develop them into modern versions using current construction methods, materials and manufacturing processes.

Sizing

The literature has indicated that the sizing of bras is a “thorn in the side” issue for today’s female fashion due to the fact that majority of women are wearing the wrong bra size. *“How many people would buy shoes without being sure they fitted? Breasts are even more individual than feet: changing hormone levels, the Pill, diet, and weight changes -all these affect a woman’s bust size. Women must fit the bra before they buy it.”*^{xii} (Fox, 1999)

Over 80% of all bra wearers in the world are still wearing the wrong bra. Many bras don’t fit women at all and others are basically the wrong shape or size. Over \$50 million was spent on bras in NZ in 2004; it is shocking that women are putting up with the sizing status quo.^{xiii}

Worse still, poorly fitting bras can lead to bad posture and neck and back problems, as well as look unappealing and bulging under garments. The following signs show an inaccurate bra fit:^{xiv}

1. The breasts bulge out of the sides of the bra cups.
2. The bra straps fall off the shoulders or dig into the shoulders.
3. The bra arches up at the back.
4. There are marks where the bra has dug into the flesh.
5. The bra does not sit properly and causes irritation around the straps or its band.

Women’s bosoms come in different shapes. Breasts can have the shape of apples, pears, cones, eggplants, melons or other irregular forms. The designer is aware that it is not possible to even consider or design a cup at this stage that fits one and all at the same time. It became clear early on in the analysis that only individual bras made to order will ensure the correct fit.

One of the most common causes of discomfort for female bra wearers is the inaccurate measurement of their breast volume. Accurate measurement of breast volume is the key to the pattern making of bra cups.

The following are some areas of uncertainty with regard to breast measurement that have been identified:

1. Inherent uncertainty exists in defining the outline of the breast: hence it is difficult to select reliable anthropometrical points.
2. Optical data of a sagged breast cannot be obtained due to hidden areas, so the bottom line of the base breast has not been fully applied to the design of the underwire and front panels of brassieres.
3. Quantification of the curved surface of the breast involves a rather complex process and mathematical equations do not provide one with simple parameters that can be easily adapted to the design process of brassieres.^{xv}

Consequently it can be seen that it is quite difficult to measure accurately some of the above-mentioned variables, especially if the individual bust exhibits more fluidity than rigidity.

Most bra designers work only on the “ideal” model size, which is 34-B. According to the market research firm NPD, the most popular bra size in the USA went from 34B to 36B in 1991 and from 36B to 36C in 2000. To arrive at tooling requirements for other sizes, designers extrapolate. Commercial sizes range from 28-AAA to 55-DD. The 34-B “ideal” is not entirely an arbitrary designation. Rather, it represents the bustline considered most pleasing to the artistic eye of most dress designers - although there is room here for disagreement. In this project the designer also works with the 34-B model size.

A number of past studies have focussed on breast sizing in order to help the wearers find the right bra fit and size. The earliest such study was in 1926 when the Berlei Company of Australia commissioned two professors from the University of Sydney to conduct the first anthropometric study. An analysis of the results showed that there existed five types of women (the accuracy of this study was confirmed in the UK in 1976).^{xvii}

Wacoal, a Japanese brassiere manufacturer, developed what they called the Silhouette Analyser. A computer draws an outline of a woman's shape and it appears on a private monitor screen. There is no film, no taping and no x-rays. A trained specialist fits the customer with a bra that will change her silhouette, based on her personal shaping needs. Then, the Silhouette Analyser draws another silhouette for comparison, proving to the customer that she can feel secure, comfortable and pretty.^{xviii}

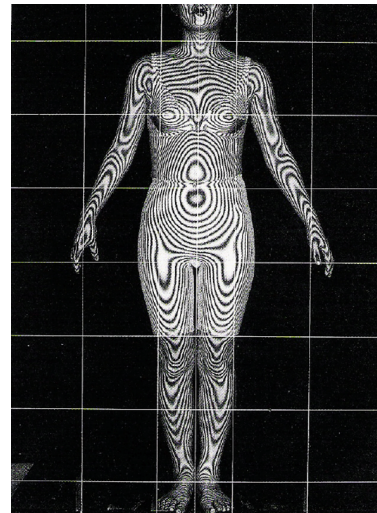


Figure 11: Wacoal Silhouette Analyser

The latest study focuses on finding the correct approach to designing a bra while not losing focus of the real issue -the establishment of correct measurements of breast volume.^{xix}

As the nature of the project involves issues concerning human factors, concentration on these features is of key significance.

This research project does not warrant the undertaking of an extended insight into the anthropometric models for breast measurements, however it does require

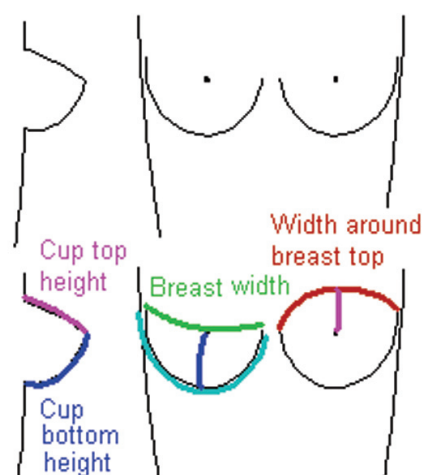


Figure 12: Designer's method of measuring the breast

that the results be examined in order to continue the planned construction process that envisages the availability of factors such as the correct breast volume in the establishment of clear parameters for the cup design.

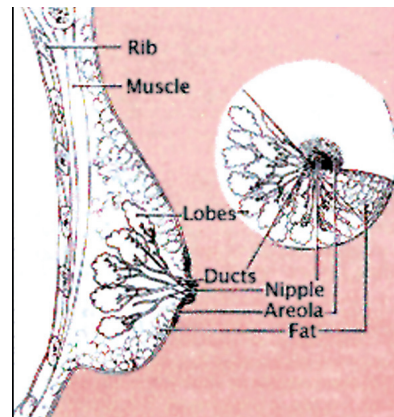
For the current research the volume has been measured manually using a tailor's tape measure.

Some Health Issues To Do with Bra Wear

The bra, just like the corset, is subject to criticism from the medical fraternity as there is some scientific evidence that there is indeed a link between the wearing of a bra and the incidence of breast cancer.

The researcher is not able to make conclusions about the comparative risks of wearing different types of bras. Some females speculate that the problem is “tight bras” or “ill-fitting bras,” but these deductions are at best guesswork. Others, on the other hand, believe that the trouble is the underwires. However these views are speculative. It is correct to say that the main link between wearing a bra and disease is due to the constriction of lymphatic circulation. Therefore, it would seem that tighter bras would be more problematic than looser ones, as tighter bras are more inclined to constrict lymphatic circulation.

The health problems mentioned above do not stop there and another couple of issues present themselves under this banner. They are breast immobilization and elevation of breast temperature. Either of these is possibly a major means of disease causation.^{xx}



Some documented case histories show that women have problems even when wearing very loose, all-cotton, “nothing bras”. (The problem is bra-related, because pain and cysts are eliminated after bra-wearing ceases).^{xxi} Other bra wearers have noticed that even wearing stretchy Lycra tank tops has caused them problems in terms of tenderness and breast pain, in comparison to wearing a loose camisole or undershirt.

“...wearing a bra ...has no medical necessity whatsoever ... Except for the women who find bras especially comfortable or uncomfortable, the decision to wear or not wear one is purely aesthetic -or emotional ... If you don’t enjoy it, and job or social pressures don’t force you into it, don’t bother.” (Love, 1990)^{xxii}

The researcher studied a number of scientific research articles that link bra wearing to major illnesses. Some are mentioned below:

1. A medical doctor (Douglas, 1978) in California published an article in a medical journal (*The Lancet*) linking bras with elevated breast temperature, and he suggested that this might have a connection with breast cancer. He studied several hundred women in a medical practice and also observed that the heavier the bra material, the hotter the breast, and that bra-free women of all sizes had cooler breasts.

xxiii

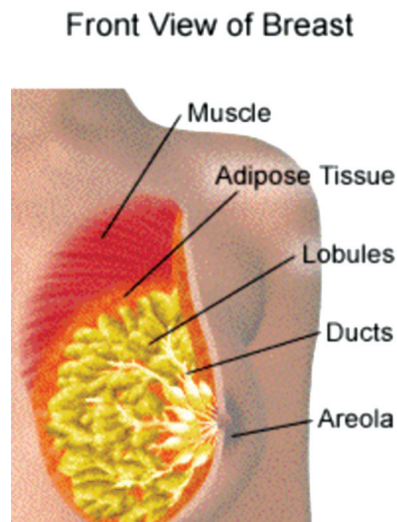


Figure 14: Front view of breast

2. In 1991, researchers at Harvard University (Hsieh, & Trichopoulos) published a medical journal article on breast cancer risk. They mentioned that the women in their study that did not wear bras had a 60% lower rate of breast cancer than the women who wore bras.^{xxiv}
3. Researchers in Japan (Ashizawa, Sugane, & Gunji, 1990) published a study on bras and sagging. They proved that a bra could increase breast sagging. This effect was most noticeable in larger breasted women.^{xxv}
4. Sydney Singer and Soma Grismaier of the Institute for the Study of Culturogenic Disease published their book, *Dressed to Kill: The Link Between Breast Cancer and Bras* in 1995. Their study included almost 4600 women, half of whom had breast cancer and half of whom did not. They found that the

more hours per day that a bra is worn, the higher the rate of breast cancer and that women who do not wear bras have a dramatically reduced rate of breast cancer.^{xxvi}

5. Many women who had concerns about breast cancer risk and breast pain quit wearing bras and then found that their pain and the cysts of fibrocystic breast disease were dramatically decreased or eliminated. Several of these women wrote their own personal case histories.^{xxvii}

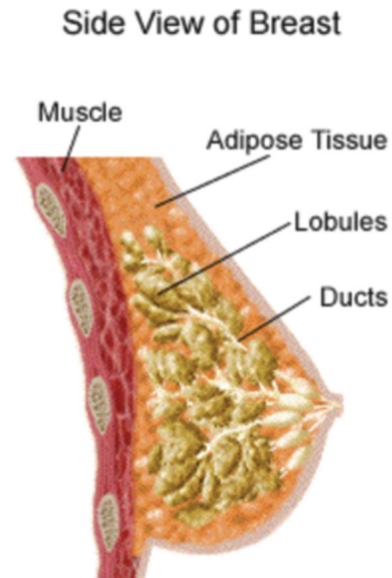


Figure 15: Side view of breast

6. A landmark study was published in the prestigious British medical journal, *The Lancet* (Dixon & McDonald & Elton & Miller) in 1999. This study showed that pre-menopausal women with fibrocystic breast disease have an almost six-fold higher risk of future breast cancer. This study firmly refutes the advice of some doctors who have said that fibrocystic disease carries no increased risk. In all, there are now over 30 published medical and scientific research articles showing a connection between fibrocystic disease and increased breast cancer risk.^{xxviii}
7. British breast surgeons conducted clinical trials at two breast clinics in England and Wales (Cawthorne & Mansel, 2000). They studied 100 women to see if going bra-free could lessen breast pain. Their study concluded that the majority of pre-menopausal women found decreased pain during a three-month bra-free study period. Doctors proved that bras cause localized heating of breast tissue.^{xxix}
8. A medical doctor (Ryan, 2000) published his findings on shoulder pain treatment in women with large breasts. In this five-year study, it was suggested that patients remove the weight from their shoulders for a period of two weeks, either by going braless or by wearing a strapless bra. Only one woman chose a strapless bra and all the others went braless. The long-

term outcome was the reduction or absence of muscle pain and tenderness. Seventy-nine percent of patients decided to remove breast weight from the shoulders permanently because it rendered them symptom free.”^{xxx}

9. However, a New Zealand breast surgeon, Dr Belinda Scott from Breast Associates Clinic, gave the following comments in relation to the theme “bra wearing and cancer health risks”:

- Bras are not responsible for any major health hazards in the breast area.
- A tight bra does not reduce the lymphatic drainage unless previous abnormality in the breast existed.
- Any fabric that alters body temperature, making it cooler or hotter, does not make changes to the breasts.
- Patients complain about wearing a bra – heavy breast patients – when a bra that is not well fitted compresses the breasts.
- Bra manufacturers actually advise consumers to reassess wearing a particular bra every six months. Bra wearers must be made aware of bra review.
- Advice to bra wearers – have a bra fitted properly, or try a different type of bra.
- There is only one recorded injury in New Zealand from wearing a bra – the underwire penetrated the chest wall and damaged a lung.
- Changing the shape of a bra will not change the health of the breast. The breast tissue changes with the hormonal status of the patient and it does not change because of what is put on from outside.
- Making comfortable bras is the most important factor for bra manufacturers.
- There is a need to design bras for older women. Cooper’s ligaments lag and the breast is ptotic.

- Large breasted women need bras that do not cut under the arms. They require very wide shoulder straps to prevent digging into the shoulders.
- Large women experience shoulder ache and backache and headaches.
- Bras are important in giving women the kind of support they desire plus they can help with a better posture.

It may be hard to believe, but a cause for breast cancer has never been determined, despite all the research money that has been spent. There have been many studies that characterise women who are at higher risk for the disease, but the risk factors established are not associated with a root cause. The researcher believes that just as in the case of a criminal bras should be “innocent until proven guilty”. After all the evidence has been collected and collated the matter of bra wearing as the cause of breast cancer remains unsolved.

In relation to the current design project the above information provided the researcher with some important points for consideration (elimination of the “ouch-zone”, straps cutting into shoulders, and breast heating) in terms of focusing on those areas that cause the most concern for the wearers and the medical fraternity. As mentioned above, the main concerns are of removing the ‘tightness’ or restriction that causes the lymphatic system to constrict, and the heating of breasts. Additionally, the problem with straps has been identified as worth further investigation with the aim of eliminating straps if possible.

Chapter 2 -Background of the Project

The researcher noted that in the past the efforts of bra designers and other fashion professionals (e.g. fabric developers) dramatically expanded the scope of the bra design process, at a time when the concept of bra design itself was only beginning to be understood. Of particular inspiration to the work the researcher proposes in this exegesis is the bra design developed by Arthur Garson. Garson explored the dynamics of different aspects of bra construction: straps, cups, under-breast bands. His work vaulted the gulf between the comfort of use and the precision of construction, his bra patent was carefully constructed, and his materials were revolutionary by today's standards. His design survives in many forms today and has a direct connection to his own experience as a director of a bra company named *Lovable Co.*

From extensive readings and research into bra development the researcher found that most modern *brassieres* need to perform all kinds of wonders for today's woman: creating cleavage where little exists, providing invisible support for those who need it or simply emphasizing women's breasts as in the ancient days of Crete. The reason for such demands in bra creation can be found in an answer to the following question: What do women want from bras, considering that the market for undergarments is fought over by men in suits and boardrooms around the world? Women's preferences and experience (fashion savvy, cultural background and role in society), women's physical characteristics (weight or age), motivational differences (aspirations, values, needs and intentions), and women's personality characteristics (personality type, attitudes, values, and beliefs), must all be taken into account by a prospective bra designer.

Women desire to look good. "*The need for novelty is only growing bigger as women seek more individualized attention.*" (Farrell-Beck, 2003,)^{xxxi} Fashion conscious women require the bra profile to harmonise with the outerwear (emphasis on female sexuality to make bras that harmonise with body-revealing styles: plunging

necklines, midriffs, halters, backless models, and strapless dresses). Moreover, the *brassiere* designer must reassure women, that the bra they have engineered will do the kind of job it is designed for, without any problems. As well as comfort and support, today's woman seeks style, well-being and figure adulation, all combined with easy care.

Computer technology has made it possible for fashion designers to transcend the limitations of anthropometry, construction and 3D visual imagining, and overcome the conflicts inherent in traditional bra design. The researcher found it very valuable in her research to rely on computer technology for the advancement of this project's objective, especially the anthropometrical-sizing issues. One of the first designers to take advantage of these means was the UK designer *Dick Powell*. In 2000 he began creating a new bra using dynamic non-linear finite element techniques to analyse the bra's structural performance. Scanning the "geometry" of a model created a computational representation of the bra on a body. The bra was then constructed using techniques usually associated with the modelling of airbags and seatbelts in cars. This enabled the non-linearity of the bra material, contact interaction with the body and large displacements to be represented.

In order to create a new bra the designer needed to reflect upon past bra designs to expose practical considerations (innovation, attraction, technology) that could play a part in creating a new bra prototype. The dominant motive for this step was the desire to discover the secrets of such designs and to translate them to current fashion and wearers' needs. Six important past bra design precursors chosen as inspirations for this research are: the *Mary Tucek* patented bra - 1893, the *Mary Phelps* patented bra - 1914, the *Cone-Shaped* bra - 1930s, the *Arthur Garson* patented bra - 1962, the *Wonderbra* 1964 and the *Bioform* bra - 2002. The designer studied 30-patented bras and found that these six were worthy of investigation due to the fact that each of them was a revolutionary design. Each introduced new ideas and concepts that had a great influence upon further bra development.

Mary Tucek's garment known as the "*Breast Supporter*" introduced separate pockets (known today as cups) for each breast; shoulder straps were broadened and hook-and-eye closures were improved. According to well-known bra historian Professor Jane Farrell-Beck (2003), Marie Tucek "discovered" the first push-up bra with separated bra cups.^{xxxii}

Mary Phelps's delicate "*Backless Brassiere*" illustrates a dynamic design change through which an apparently static bra design was reinvented. By using soft and lightweight materials, the new invention separated the breasts naturally. It did not have cups to support the breasts, but flattened them instead. In contrast, the *Cone-Shaped* bra used a new technique called "*whirlpool*" stitching. This was used to give the breasts support in a cone-shaped bra cup and it was dubbed the "*bullet bra*".^{xxxiii} The absurdity of this exaggerated high, pointed bosom was that it related only to "*the female form in African sculpture*" rather than real women's attributes.^{xxxiv} (Yalom, 1997). This bra utilised a new stitching technique, and it is an important example of bra design progress. The *Wonderbra* on the other hand, was a new concept in bra design, in which the fashionable push-up effect was created with the help of 54 structural elements. This was purely a "visual undergarment" accentuating a woman's bosom. Conversely the *Bioform* bra of 2002 attempted to neutralise some of the structural aspects of the *Wonderbra* that cause wearers discomfort -underwire that creates the "ouch-zone", padding that heats the breast, and straps that cause shoulder strap-cutting that injures shoulders and back.

The designer's unstructured push-up plunge bra differs from the above-mentioned designs by creating an undergarment that has no structural elements (underwire, padding, boning, etc.). The design proposed here produces the required push-up effect while delivering comfort and well-being to the wearer.

Over the past two years, the designer has developed four bra designs, which have extended and improved the dynamism of some of the previously mentioned bras (those of *Mary Tucek*, *Mary Phelps*,

Arthur Garson and the *Cone-Shaped* bra). What these all share in common is the treatment of breast comfort and support as bases of dynamic design simulations for the new bra prototype.

The designer has used imagination and construction techniques to create this series of four bras with aesthetics, comfort and efficient potential manufacturing processes as key design criteria.

In the next chapter, the designer details the principal design and technical criteria used in the development of the unstructured push-up plunge bra.

Chapter 3 -Methodology

In this chapter the designer presents the methodology of the project. Firstly, to show the investigative nature of this project and secondly, to show how the new prototype unstructured push-up plunge bra was realised.

Research methods in bra design are to a great extent pro-active, requiring the fashion designer to research through “action,” and then evaluate such “action”, “*a reflection in and on action*” (Schön, 1983).^{xxxv}

This research therefore was action oriented, based on a holistic approach to the subject of bra development, taking into account all matters that influence bra design: materials, technology, anthropometry, medical science, fashion in general, and female expectations.

An heuristic methodology was the principal research method of this project. This was a qualitative research method, concerning “*any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification*” (Strauss & Corbin, 1990).^{xxxvi} This process involved both, the designer’s internal search (intrinsic knowledge) and external search (outsourcing expertise and materials) through which the designer discovered the nature and meaning of further investigation and analysis.

The designer solved a problem when no formula existed for solving such a problem. Informal methods and the designer’s tacit knowledge and experience were applied; this method includes all forms of trial and error: experimental, scientific and descriptive processes.

As this is an Art and Design practice (*Creative Production Project*) the methodology involves the development and testing of a body of work (different bra design prototypes) through reflective questioning.

In the first instance there was an incubation period in which the designer gathered information about what had transpired to date in bra design. Secondly, the designer moved into the illumination process with the creation of new solutions. *“Ultimately a comprehensive depiction of the core or dominant themes are developed.”* (Moustakis, 1990)

The reason why this was the correct method to use was that heuristics are suitable for exploratory research. Intuition and empathetic insight were used during this heuristic discovery.

By following this method, the designer optimised the chance of discovery by being open to new concepts, past and current bra designs, being user-centred, being aware of the need to change the research questions during various stages of the research process, creating maximum structured variation of perspectives, and discovering similarities and patterns.

This was a trial and error method, which necessitated trying out new bra design prototypes to see whether they worked (performed user tests on the female bodies, employed expert opinion to critique the design). If a prototype worked (no structural components used and bust fully contained in a cup – no flesh hanging out on the sides, push-up effect achieved) then this was the right design- solution. If it did not work – there was an error – then another design prototype needed to be made.

In this trial and error process, the best design was viewed first, followed by the next most likely, and so on until the right design was found or until all possible designs were tried and tested.

The various options were examined and an additional tool was used to evaluate them: this tool was the product questionnaire, which had the following format (Fig. 16).

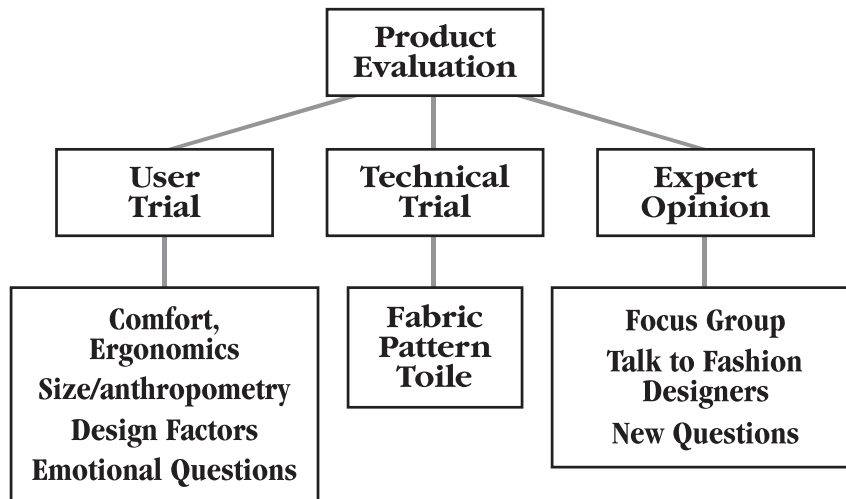


Figure 16: Product evaluation method

The trial and error method oscillated between a problem-specific and non-optimal method looking to find a specific solution, which may not be the most optimal for this design purpose but the best possible considering current technology, materials, fashion trends and women's expectations.

This methodology relied on various sources of information: the place of work, design studios, art and design literature, plus a dialogue with various designers and users of the bra all within the heuristic context of the project. Furthermore, the design process of trial and error became the most significant process in finding the appropriate result.

In the context of the above formulated discovery steps the experimentation moved between the bra designs of *Mary Tucek*, *Mary Phelps*, *Arthur Garson*, the *Cone-Shaped* bra, the *Wonderbra* and *Bioform* bra designs, CAD, material technology, breast cancer concerns through current fashion trends and female expectations. Finally, the practice was finalised by the design of an innovative new bra.

The methodological approach and structure of this research was based on the nature of the project. The outcome of this research was a creation of a new bra that is practice-oriented as well as focussed on human and technical factors: it is user-centred, material tested, and science-based (technological, structural, mechanical,

etc.). The design incorporated the latest available bra materials and construction innovation that eliminates structural elements from bra design.

The bra interfaced a range of designs from the first patented bra in 1893 to the current design of the *Bioform* bra. The bra design demonstrates the ability to use new technology and to integrate modern engineering and IT (computer software) methods that are interdependent and harmonious.

A new bra prototype that was fashionable and comfortable, that created a push-up effect without the use of structural elements – the key design criteria validated of this project.

At this point the question arose as to where, within the domains of fashion design, pattern engineering or female psychology, this exegesis was positioned. Even though the researcher based design criteria for the new bra on findings from current sciences, and used techniques from industrial design in order to implement these criteria, the designer wishes to emphasise that her attitude to the combined information of these disciplines is goal specific. In other words, it was not the designer's goal to conduct original research in either human psychology or industrial design engineering, but rather to select and combine the fruits of these domains into a novel design that advanced the field of bra design and construction.

Chapter 4 -Design Criteria and Development

The most important information needed for the design and development of this series of bras was related to users' requirements.

How good a bra is, depends directly on how well it does its job. And its performance, of course, depends upon its design. Obviously, the starting point for engineering/designing a bra is to find out who is affected by or influence the bra design and what bra wearers want. In relation to these issues, the researcher identified the following types of persons who could influence the bra design:

- Customers who wear bras.
- Individuals who sew the bras
- Those who design and supply fabric for the bras
- Individuals who sell the finished product
- Bra designer or designers.

Due to the scope of this project the researcher focussed her efforts on the desires of the bra wearers -customers and the designer herself. Users of any product, and the designers, do not usually share the same knowledge, and it is paramount to bridge the gap between them to enable an understanding of what is to be achieved. Otherwise the customer will have to use a product that is not designed for them.

Therefore, in this project, to ascertain the current expectations of bras by wearer's, ten subjects (age range 16 - 49 years old) were asked to give their opinion on the project bra's performance to help improve the concept. Two of the participants were garment experts, each with 20 years' experience in lingerie design. The rest of the subjects were chosen for their body and bust type. Each woman was asked to provide an objective account of experiences while wearing the bra. In the trial the participants were asked to wear the bra for a 200-hour period, and some of the questions asked of the participants are shown below. The questionnaire in full can be found in Chapter 7.

The questionnaire questions.

1. Does the new prototype bra have a function (does it hold breasts properly, is it fashionable)?
2. Does it compress the bust?
3. Does it shape the bust?
4. Does it have a push-up effect?
5. Is the bra comfortable?
6. How does the bra compare with the one that you usually wear?

The four technical trials from the four-patented bras gave the designer considerable insights relating to good bra design criteria.

These include insights into:

- The semi-solid mass of breast tissues
- The different shapes of the breasts and areola
- The different sizes of the individual breasts
- Creation of the “ouch zone”
- Relationship between the under-bust band and the shoulder straps that affect the cups.

Using these insights plus tacit knowledge the designer's next step was to design, develop and evaluate the final “*Octi*” bra (the designer's name for the new bra prototype). The designer's inspiration for this bra came from marine creatures: the octopus and jellyfish, a bionic link between nature and humans.

In the process of doing the work, that has led to this project, and through conversations with numerous collaborators among them *Larry Cross* – a Bendon bra designer; *Ian McEwing* – the previous owner of Bendon; *Gale Williams* – a lingerie designer, for Bendon;

Claire Morgan – the Bendon Marketing Manager; *Dick Powell* – the designer of the *Bioform* bra; *Patricia Cadolle* (the grand-daughter of *Herminie Cadolle* - the first bra designer to divide the corset into two parts)– a lingerie designer and owner of Cadolle Lingerie; *Jane Farrell-Beck* a bra historian at Iowa State University; *Dr Belinda Scott* – a breast surgeon at Breast Associates; as well as discussions with users, and through visits to lingerie manufacturers (among them *Cadolle* in France, *Samanta* in Poland and *Bendon* in New Zealand) the research established some important design criteria for the design of an unstructured push-up plunge bra (*the “Octi” bra*). These criteria, taken together with the design challenges they entail, comprised the main criteria, that directed the execution of this project’s work.

Design criteria:

1. Elimination of underwire, padding or boning used in bra garments while creating the push-up effect as if the structural elements existed
2. Reduction of a heat build-up on the breasts and reduction of restriction of the lymphatic system
3. Elimination of the strap cutting into shoulders by improved engineering/construction techniques
4. Reduction of fabric used to create an innovative new bra by using a minimum of fabric
5. Elimination of fabric allergy by utilising the latest body-friendly lingerie fabrics
6. Creation of a fashionable bra desired to be worn by consumers
7. A performance bra – the new “Octi” bra is comfortable, healthy, and aesthetic and has the desired support. The technique of construction/moulding can be used in different pattern cutting styles.

In the course of pursuing the above design criteria, the designer expected to encounter and develop solutions to the above-mentioned technological and human challenges.

Chapter 5 -Design Process

The project began in earnest after a period of becoming familiarized with the six patents (those of *Mary Tucek*, *Mary Phelps*, *Arthur Garson*, the *Cone-Shaped* bra, the *Wonderbra* and the *Bioform* bra) and a step-by-step process to create four bras using the patents for inspirations.

Firstly, the designer established and created parameters for the process.

Mannequin and Fitting Model

For the process of qualifying and quantifying the information, mannequins and a fitting model presented an array of measuring and fitting opportunities and formed an integral part of the discovery process. One model and two mannequins (one a dress form and the other a display) were used for this project. Both model and mannequins had size 34B measurements.

Step 1

Two somewhat different soft moulded cups were created to imitate a real bust - on mannequin number 1. The designer made two different cups to get a good average bust size - as shown in Fig. 17 (there are actually five different bust shapes for the average female; the designer took a middle ground).^{xxxvii}

From this the designer could work accurately towards the trial fittings on the model in size 34B and for the other mannequin.



Figure 17: Mannequin number 1

Step 2

By experimenting on mannequin number 1 using new cups the designer could see when a bra did not fit properly. However the designer did realise that a perfect shape – as that of the available model -is not always the true shape.

Step 3

The designer also inserted silicone gel in the cup to imitate the bust and the movement of the breasts along with the squashing or gentle lifting of the bosom.

Step 4

A study of the bust anatomy was conducted, and a bust was built on the mannequin. The designer drew the lymph nodes, areola and “ouch-zone” areas in order to engineer a bra that would prevent pressure in these stress areas. This problem still needs further research, but this undertaking has started this process.

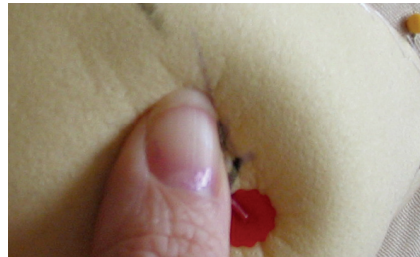


Figure 18: A mould made of bra-cup fabric and silicone

The designer was aware of the fact that it was possible to create a push-up bra without structure for a smaller bust (34A, B and C). The fundamental principle of this is based upon a combination of:

1. Smaller size bust
2. Pattern cutting
3. The fact that the fabric and seam can in principle hold the volume of the bust up

Furthermore, the breasts can be enclosed in such a cup without overflowing. However this concept does not hold true for this designer, as the true unstructured push-up plunge bra could work on a small or larger bust with the same premise.

Step 5

To create the pattern for the new prototype un-structured push-up plunge bra the bust volume was turned from the side and down or from the nipple bulged down. The pattern could then be created around either shape. Either way the bra disturbs the lymph flow. However, according to Dr Belinda Scott of Breasts Associates

(March 2005), the problem is predominant only with ill-fitting bras.

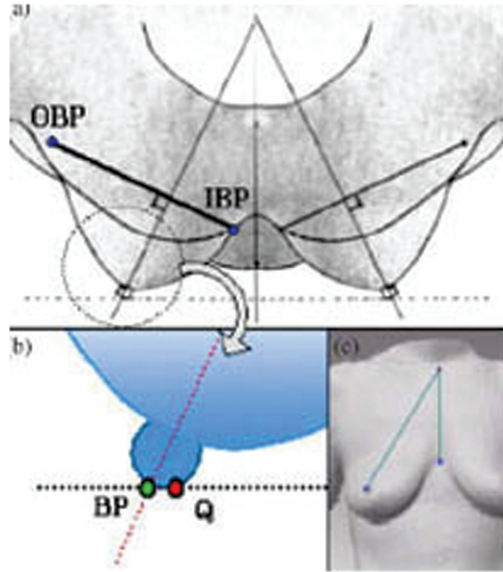


Figure 19: Measuring systems

Step 6

Observed from the side a bust forms a natural curve underneath. This curve is often not taken into account in commercially available bras.

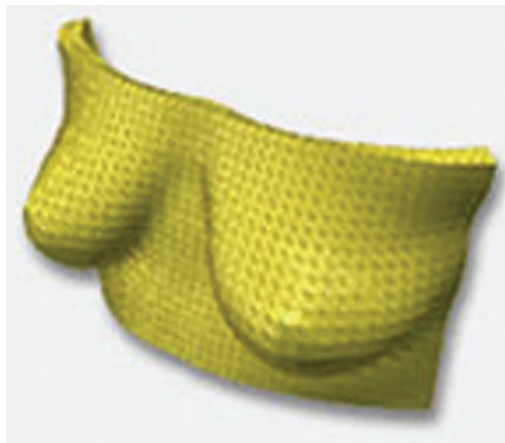


Figure 20: A mesh mould of the breasts

Measuring process

Step 1

Surface measurements were used for the pattern making of the bras in this project. The outline of the breast is difficult to define by just looking at the shape of the breast. The breast covers the area between the mid-axillary line and the sternum and overlays

the anterior serratus and the pectoralis major muscle. The upper and lateral portion of the breast extends into the axillary region.

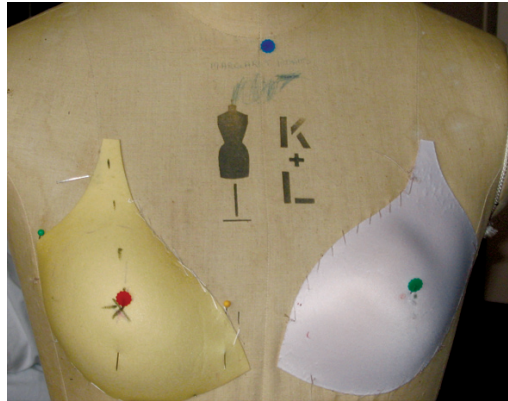


Figure 21: Mannequin number 1 – view from the top

Fig. 19 shows the outer breast point (OBP), the breast point (BP) and the inner breast point (IBP). They are on the same horizontal line when wearing a bra and are used to calculate breast volume (Q).

The reference points that are important are the three data points shown in Fig. 22

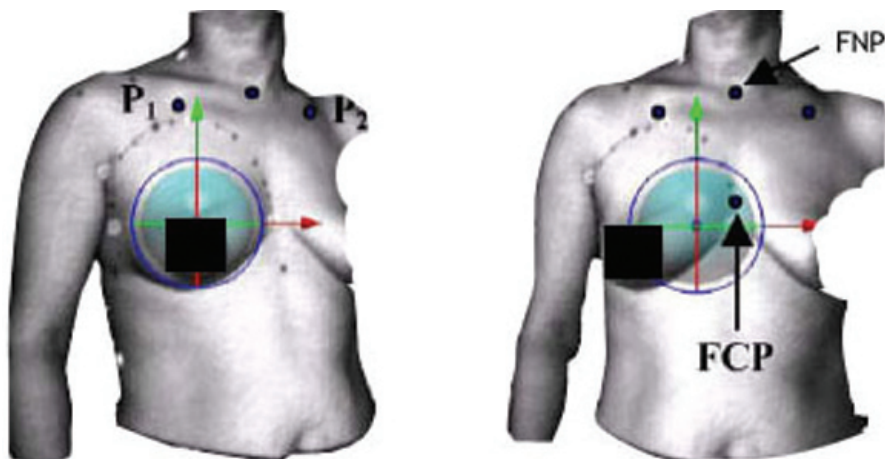


Figure 22: Breast measurement reference points – front and side view

Front view and side view of the breasts: front neck point (FNP); front centre point (FCP); P1 and P2 two points at a distance from FNP.

The accurate measurement of breast volume is the major key to making a successful pattern of the bra cup. The researcher has already described the underlying problems facing

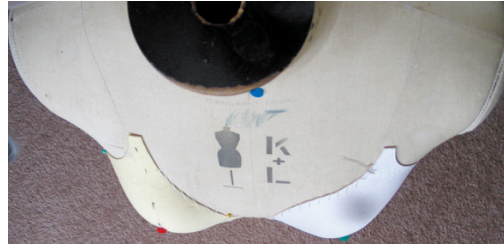


Figure 23: Breast measurement points

the designer with regard to the anthropometrical- sizing needs of the female breast. These however needs to be addressed early in this design process.

Step 2

While the bottom of the breast line provides the structural base line of the bra, the measurement of the breast volume provides the pattern for the bra cup. In this project the shape of the breast was not restricted to a simple pattern-cutting method but related to anatomical structure. A previous study on the measurement of breast volume using a mould technique (a radius circle) was beneficial in terms of simplicity, but to design for an unstructured push-up plunge bra anatomical measurement was needed due to the fact that this bra works with the muscular movement of the body. ^{xxxviii}

Step 3

The draping method of pattern making was applied at certain stages to build in uplift without disturbing the lymph nodes too much.

The designer used heuristic approaches and followed a new path of discovery; each step being documented as it occurred.

Analysis, Design and Evaluation of Prototypes

The following is a detailed study of the chosen designs that contributed to the designer's own concept of the "Octi" bra. The evaluation of each bra enabled the researcher to promulgate her own presumptions, upon which her unstructured push-up plunge bra was based.

Mary Tucek – 1893

The designer chose this bra because it was the first designed and patented push-up bra. The challenge was to consider its push-up effect, and to fit and establish the negatives and positives of non-stretch fabric in order to achieve comfort and good fit.

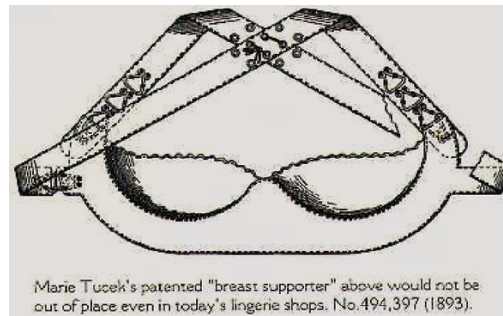


Figure 24: Mary Tucek bra patent

Design and Development of the Prototype

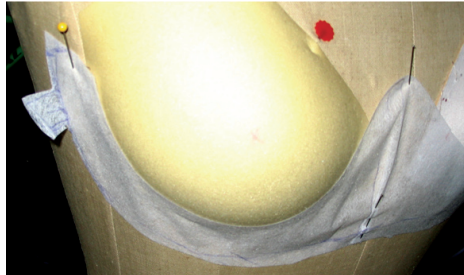


Figure 25: The start of the toile



Figure 26: The toile completed. The cup shape is at a 45-degree angle



Figure 27: Two thin attachments and elastic keep this bra firm on the body



Figure 28: Front view of the toile



Figure 29: The bust point and the attachments are on the same level



Figure 30: Working on frills



Figure 31: Final design with embellishments



Figure 32: Designer's version of the *Mary Tucek* bra plus matching briefs – front view



Figure 33: Designer's version of the *Mary Tucek* bra plus matching briefs – back view



Figure 34: Close-up of the designer's interpretation of the *Mary Tucek* bra

Figure 35: Summary of the Mary Tucek bra

Bra patent	Positive aspects	Negative aspects
<i>Mary Tucek</i>	<ul style="list-style-type: none"> • Operates with only two thin attachments and elastic 	<ul style="list-style-type: none"> • The under bust gets squashed by the metal under the breast band. This inflexible metal breast band must have moved with the body, like the wire of today • Hygienic concerns presented themselves, such as: sweating, odour, rash and injury from the metal band • This bra cuts into the under arm like most of today's under-wired bras • This bra is impossible to make without structure • The bra cups squash the bust producing the cleavage effect in an ill-fitting manner

Designer's Interpretation of the *Mary Tucek* Bra

1. The designer recreated and reinterpreted this design as a size 34B.
2. The designer experimented with the bra (looked at the push-up effect, the “ouch zone” cutting and shoulder cutting).
3. The designer experimented with a medium weight two-way stretch fabric -to establish whether it was strong enough to hold the bust without creating draglines.
4. The shape of the demicup was designed to have a similar silhouette as the original cup.
5. The *Mary Tucek* bra was reinterpreted and created with underwire replacing the steel plate. The demi cups were constructed from lingerie foam.
6. The designer found that the bra collapsed (the bra did not perform on the body).
7. The designer recreated this style using foam in the cups and the underwire to create push-up. This was done to establish a bust-lift, this design performed with straps because without straps it fell off the body. The use of straps created substantial shoulder cutting.
8. The cup for the “*Octi*” bra will have to be at an angle, and not like a demicup.

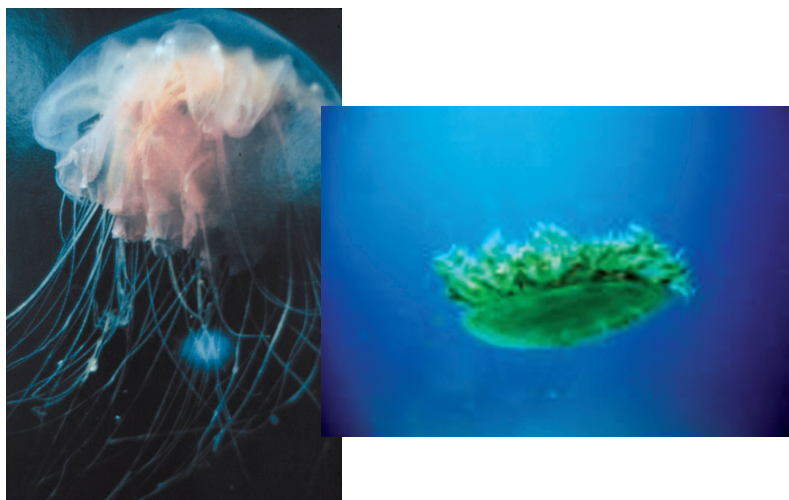


Figure 36: The inspiration for the *Mary Tucek* bra



Figure 37: Detailed view of the *Mary Tucek* bra cup

Outcomes of experimenting with this Design and Fabric

- The bra was modified, as it proved impossible to recreate without structure (a power net, an underwire and lingerie foam was used).
- It is possible to work with a medium weight, two-way stretch fabric and achieve the desired results; it reduces stress on the fabric.
- Breasts get pushed up, as there is a lot of pressure on the breasts.
- The angle of the axial points and shoulder straps will be used in the final design.
- The garment could be made with a smaller amount of fabric.
- Bra function around the torso and shoulders: because a “steel plate” was used, it had to be very tight on the body and shoulders in order to remove friction.



Figure 38: Designer's version of the *Mary Tucek* bra

Mary Phelps -1914

The designer chose this bra because it was one of the soft cup versions of the 1914 -1929 period that stood out due to its simplicity in design. This is significant in this project, as the final product has soft cups.

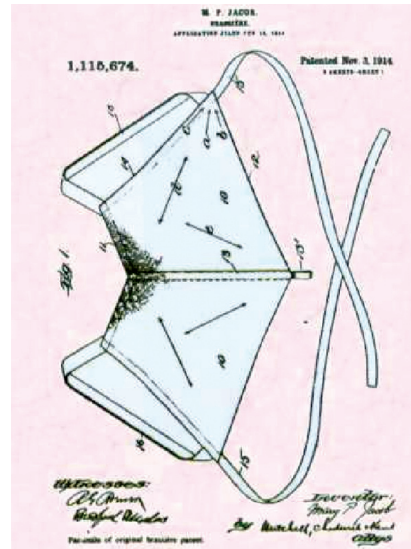


Figure 39: Mary Phelps bra patent

Design and Development of the Prototype



Figure 40: The toile takes shape

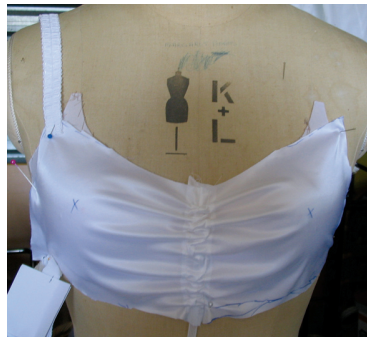


Figure 41: The toile being assessed for fit and function



Figure 42: The reinterpreted version of the *Mary Phelps* bra



Figure 43: Bra fabric minimized



Figure 44: Raw edges finished



Figure 45: The toile being tested for shoulder cutting and lift-pressure on the bust and around the torso



Figure 46: The toile testing



Figure 47: The final toile

Designer's Interpretation of the *Mary Phelps Bra*

1. The designer recreated and reinterpreted this design as a size 34B.
2. The designer created soft cups (but kept the outline and style) -to test the cups, as the final design was also to incorporate soft cups.
3. The designer experimented with a lightweight two-way stretch silk - to establish whether it was strong enough to hold the bust without creating drag lines.
4. The designer cut out decorative pieces and inserted see-through lace to observe cleavage and to establish if the bust is picking off the chest wall.
5. The designer used a smaller amount of fabric to see if the bra performed with the same effect as one using more fabric, then tested to see how small this garment could be while still retaining the qualities of a good bra.
6. 6mm width elastic was used - to keep bra on the body.
7. It was established whether shoulder cutting existed.
8. The "ouch zone" was looked at for possible cutting.

Outcomes of Experimenting with this Design and Fabric

- It is possible to work with a lightweight fabric and still achieve the desired results. However a medium weight will reduce stress on the fabric.
- The breasts get pushed together from the sides with elastics and rings working around the body.
- The bust point and axial level are at the same point.
- The bust points about 2 cm closer together creates cleavage.
- The garment could be made with a smaller amount of fabric. As part of the project, the new bra was made with a small amount of fabric.
- The bra function around torso and shoulders.
- Little pressure on the bust.



Figure 48: Finished - designers interpretation of *Mary Phelps* bra

Figure 49: Summary of the Mary Phelps bra

Bra patent	Positive aspects	Negative aspects
<i>Mary Phelps</i>	<ul style="list-style-type: none"> • Makes for little disturbance of the bust • Bust points move 3cm closer together • Creates a push-up effect • Creates no “ouch zone” cutting • The bust is lifted off the chest wall 	<ul style="list-style-type: none"> • The bra straps cut into shoulders, on the scale 1-5, at 3 • The bra can only be worn with certain garments like sleepwear



Figure 50: The inspiration for the Mary Phelps bra is from the observation of a jellyfish

Observing a jellyfish in motion -its lightness in movement and colour, influenced this design, as it compares well with the movement of the bra on a body.

A lace overlay was introduced and draped over the silk to create a luxury look for the final design. This brings the weight of the fabric up as well.

The recreated soft cup required specialist pattern cutting and construction to create a 3 D look with a V at the under bust. A cup was introduced to create the bust lift -instead of the flattening silhouette of the original *Mary Phelps'* bra..



Figure 51: The final design of the *Mary Phelps* bra with lace overlay

Arthur Garson – 1962

This bra was chosen for examination and experimentation due to the fact that it was the first patented strapless bra, and for the designer's underlying criteria for the final design: the engineering of a bra that eliminates or reduces straps cutting into the shoulders.

Arthur Garson was awarded a patent for a completely self supporting strapless bra that does not require auxiliary

supports such as uncomfortable wires or bones in the breast cup. To accomplish this feat, Garson departed from conventional materials practice in that he used plastic in his design.

Sandwiched into the outer triangular sections of the new strapless cup are curved and flexible plastic stiffening members, shaped to conform to the conical side portions of the cup. These impart rigidity and upright self-supporting characteristics to the cup.

The cup itself is made of a stiff but flexible material, which cooperates with the laterally spaced plastic members to impart additional support. Plastics are currently also used in place of wires.

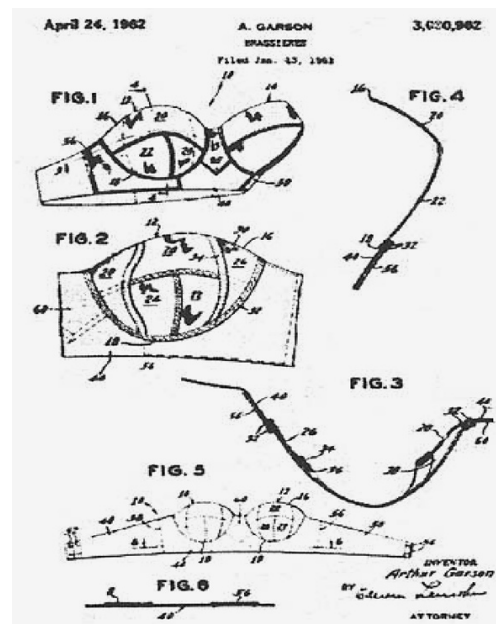


Figure 52: Arthur Garson's patent

Design and development of the prototype

Step 1

The pattern and toile of Arthur Garson's bra created according to the patent and diagram.



Figure 53: The toile

Step 2

A set square underneath the cup indicates the flat shelf-like surface.



Figure 54: Pattern – side view

Step 3

The designer recreated and reinterpreted this design to a size 34 B.

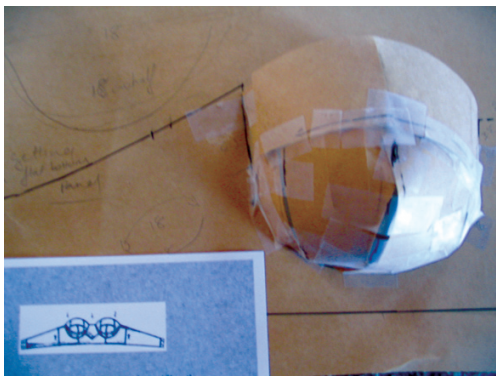


Figure 55: Pattern – front view

Step 4

A French pattern cutting method is used. Comparing a commercial pattern to the Arthur Garson's pattern cup, the commercial version is at 45 degrees, whereas the Arthur Garson pattern has a flat shelf at the base of the breast, which then curves upward to form a natural cup for the breast (see Fig. 54).

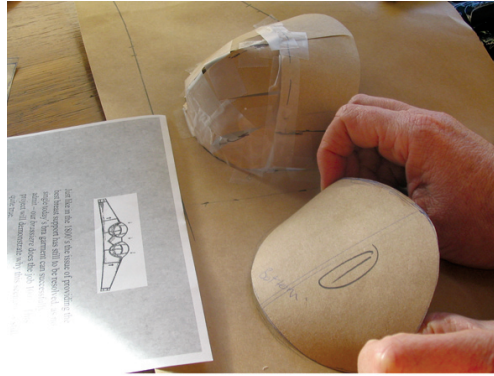


Figure 56: Comparing patterns

Step 5

This bra is made without structure and collapses completely.



Figure 57: Unstructured version

Step 6

The designer's technical version of *Arthur Garson's* bra.



Figure 58: Technical structured version

Outcomes of experimenting with this design and fabric

The bra stays on the torso because:

- The cups fit like a glove
- The structure of the design enables this
- The firmness of the under- bust band enables this also
- It has proved impossible to do this style without structure.



Figure 59: Back view of the bra

Figure 60: Summary of the *Arthur Garson* bra

Bra patent	Positive aspects	Negative aspects
<i>Arthur Garson</i>	<ul style="list-style-type: none"> • The under-bust band is firm • The stretch factor of the under-bust band is 20% more than a bra with straps due to the fact that this bra does not have any straps to support from the shoulders; it utilises garment engineering around body • The cups were originally made using anatomy measurements rather than the simplicity of existing pattern-cutting blocks • The bust rests on the plate before it shapes up, causing minimal disturbance to the body • What gives this bra a good performance is the 3D cup, shaped by seams, obviously to accommodate boning, but the designer did not use the structural elements here 	<ul style="list-style-type: none"> • The original bra of <i>Arthur Garson</i> is heavily structured • The wire cuts into the underarm -creating the “ouch zone” • The bra collapses completely without structure

The Cone-Shaped Bra – 1937: Big Is Good!

The designer has chosen the “*Cone-Shaped*” bra because it was the start of the “bigger is better era” in bra wear and of the age of new techniques for controlling bust shape.

Lana Turner propagated a new look, a look that enhanced female breasts.

The latest and newest technique, called “*whirlpool*” stitching, was used to give the breasts support in a cone-shaped bra cup.^{xxxix} It was dubbed the “bullet bra”. The absurdity of this exaggerated high, pointed blossom was that it related only to “*the female form in African sculpture*” (Yalom, 1997) rather than real women’s attributes.^{xl}

A visit to Auckland Museum was undertaken in order to scrutinize these bras and evaluate them (rather than reconstruct them) due to the fact that there are a great number of designs focussed on this shape bra.

The bras were evaluated for shape, silhouette and lift.



Figure 61: Lana Turner



Figure 62: Whirlpool stitching

Designer's Interpretation of the “*Cone-Shaped*” Bra

1. The famous spiral stitching and firm fabric of that era gave this bra rigidity.
2. The designer experimented with a different interpretation of the “*Cone-Shaped*” bra and used pin-tuck stitching instead of whirlpool stitching.
3. A new *Cone-Shaped* bra was designed with only certain reworked elements from the original “*Cone-Shaped*” bra, resulting in a soft-cup triangular cone-shape with vintage inspiration.
4. No wire was used in this style.
5. While evaluating this bra the designer revealed triangles in the silhouette, under cup, as well as in the upper outline of the bra. This influenced the triangles of the cups that the designer had created rather than the famous *Cone-Shaped* design.

Technical trail and Work Involved in the Reinterpreting of the “Cone-Shaped” Bra

Step 1

This particular bra has been reinterpreted many times ,and the designer wanted to fashion

something different and original while still having good function and shape.



Figure 63: Start of the toile

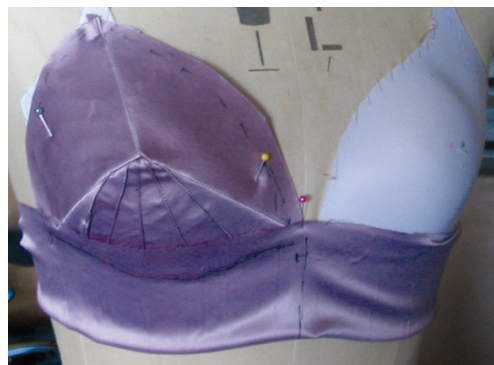


Figure 64: Continuation of the toile 2

Step 2

Development of bra cones.



Figure 65: Bra cones

Step 3

Final drawing of bra.

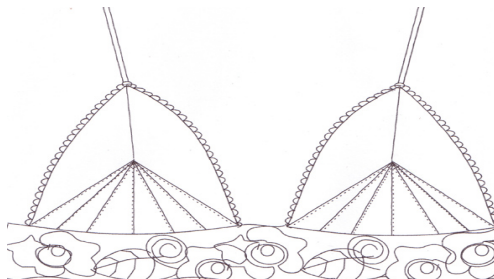


Figure 66: Final drawing

Outcomes of the Experimentation with the “Cone-Shaped” Bra

- Soft cup creation with medium weight material lifts the bust and gives the desired bust shape but cuts into the shoulders.
- A soft-cup bra is created with a lift effect, which is made possible by stitching lines into a cone form.
- The under-bust cup is shaped at 45 degrees but because there is no structure the cup drops back to form a plate underneath. This is reinforced with stitching pin ‘tucks’ to give the fabric firmness.
- The under-bust band needs to be wider to assist undercups in keeping the bust up.
- Further experimentation lead to the development of a triangular shape with a soft cup.
- When the shape of the bust is changed by putting it into a cone (“pyramid”) - shaped bra the shoulders take more pressure from the straps.
- The under-bust band is firm around the torso as copied from the previous design (*the Arthur Garson bra*).
- The same principals that *Arthur Garson* used around the torso is followed in this design to eliminate shoulder cutting. However the triangular shape of the cups -which is artificial - prevents this bra from eliminating 100% of shoulder cutting.

Figure 67: Summary of the “Cone-Shaped” bra

Bra patent	Positive aspects	Negative aspects
<i>“Cone-Shaped”</i>	<ul style="list-style-type: none"> • Lift achieved by seams in the under cups -these seams create a similar effect to the spiral stitching achieved for the push-up effect • The under-bust band is firm around the torso 	<ul style="list-style-type: none"> • By creating an unnatural shaped cup the shoulder cutting is increased • The bust is squashed at an angle • More pressure on the shoulders



Figure 68: Designer's interpretation of the "*Cone-Shaped*" bra



Figure 69: Designer's inspiration for the bra



Figure 70: Final version of the “Cone-Shaped” bra

Wonderbra – 1964

This bra was examined for its push-up effect. To produce the push-up effect in the *Wonderbra* the first designer used 52 components.^{xli} The bra created an excellent fit; it could be fashioned in many different styles and on occasions could even be worn as an outer garment.



Figure 71: The *Wonderbra*

The designer did not undertake the recreation of this bra due to the fact that this garment is readily available in stores today. It is made in different fabric and styles, and adding another style did not further this project. Instead, the designer decided to evaluate the *Wonderbra* to find aspects of its construction that could add to her new “*Octi*” bra concept.

The Following Steps Were Undertaken for the Purpose of Evaluating the *Wonderbra*

- The bra was displayed on a model, as well as worn by the designer, to find out the fit and the push-up effect.
- The function of the wire was evaluated and the negative effects of its function were determined (injury to the body, promoting a premature wear of the fabric, damage to washing machines).
- The cup padding was analysed for functionality and purpose to establish the need of this feature in the design.
- The bra was taken apart to find out its construction and pattern components the elements of the bra were gathered and evaluated for their overall place in the bra and their purpose in the design.
- Shoulder straps were given a performance test to ascertain the effects of pressure of the straps on shoulders and their effect on the wearer.

Figure 72: Summary of the *Wonderbra*

Bra patent	Positive aspects	Negative aspects
<i>Wonderbra</i>	<ul style="list-style-type: none"> • The bra gives very good cleavage • The under-cup has a flattening effect to push the semi- solid mass of fluid up • The bra can be worn with most fashion styles • The wire acts as a support mechanism (just like a wire supporting a bridge's pier - wire cages for the cups duplicate wire ropes supporting the bridge's roadway) that moves with the body-shift 	<ul style="list-style-type: none"> • Wire creates an “ouch zone” and restricts natural lymph flow in the breasts • The straps cut into the shoulders, on a scale of 1 to 5, at 4 • The bust is squashed up at a 45-degree angle • The padding fills the under-bust where the cups push the breast mass up

Bioform Bra – 2002

This bra was examined for the lack of the underwire.

A radical approach in the design process of this bra was undertaken and the help of experts from the industrial design field, anthropological field and the IT field was commissioned. Based upon their discoveries they created

a new product that replaced the underwire in a bra – a revolutionary breakthrough.^{xlii}



Figure 73: Bioform bra

The Following Steps Were Undertaken for the Purpose of the Evaluation of the *Bioform* bra

- The bra was worn by the designer as well as displayed on a model to find out the fit, and the push-up effect
- The function of the three-dimensional cup support (the “internal keel” and a soft body-forming elastomer) was evaluated and compared to the *Wonderbra* underwire.
- The positive effects were evaluated in particular the elimination of the “ouch factor.”
- The lack of cup padding was noted and the use of non-stretch fabric in the cup was compared with other bras.
- The bra was taken apart to find out its construction and pattern components. The elements of the bra were gathered and evaluated for their overall place in the bra and their purpose in the design.
- Shoulder straps were given a performance test to ascertain the effects of pressure of the straps on shoulders and their consequential effect on the wearer.
- The use of new materials was examined to assess the technological properties of this new bra.
- The use of wiring that was the basis of success for the *Wonderbra* was replaced by a moulded polypropylene element that was to overcome the “ouch zone” that the wiring caused. The *Bioform* bra’s principal designer and millions of female bra wearers identified this as the problematic area under the arm where the underwired bras dig in and pinch the flesh.



Figure 74: The “internal keel” as it appears on the body

Figure 75: Summary of the *Bioform* bra

Bra patent	Positive aspects	Negative aspects
<i>Bioform</i> bra	<ul style="list-style-type: none"> • The polymer pads act like a wire • This bra creates good push-up effect • The bra fits comfortably but causes heat build-up and becomes quite uncomfortable during the day due to stiffness • The bra does away with the “ouch zone” • The moulded polypropylene provides a shelf for the under-bust 	<ul style="list-style-type: none"> • Wearing this bra is like wearing an armour plate • The fabric is very stiff (no stretch) which can also contribute to the push-up effect • The garment moves with the body • The breast flesh gets trapped on the ribcage causing heat build-up • The straps cut into shoulders, on a scale of 1 to 5, at 3 • The bra is highly structured (by using an elastomer)

To summarise the above prototyping and evaluation of the six chosen bras the designer further describes the concepts that she utilised in the creation of the unstructured push-up plunge bra that she discovered through intelligent questioning and some guess-work concerning the above-mentioned designs..

Summary of the Ideas to be Used in the Engineering of the New Bra Prototype

Bra Design	Inspirational concepts
<i>Mary Tucek</i>	<ul style="list-style-type: none"> — The bra functions with only two thin attachments and elastic. — The attachments are parallel with the bust point.
<i>Mary Phelps</i>	<ul style="list-style-type: none"> — The use of the soft cup to produce cleavage — The use of the bust point and a back bra-band that are parallel — To limit the amount of fabric used without compromising fit — A simplified technique to finish raw edges that will be used in the final design
<i>Arthur Garson</i>	<ul style="list-style-type: none"> — The shelf-like plate under the bust — The fact that the cup fits so well made the designer think about remeasuring the bust volume for her own designs
<i>Cone-Shaped</i>	<ul style="list-style-type: none"> — Spiral stitching to create the desired shape and lift for the bust
<i>Wonderbra</i>	<ul style="list-style-type: none"> — TThe use of the minimum amount of fabric — Flattering garment and style
<i>Bioform</i>	<ul style="list-style-type: none"> — An under cup-shelf concept that will be reinterpreted — The under-cup shapes perfectly under the bust

Chapter 6 - Design and Development of the “Octi” Bra

- Fashion thrives on newness, novelty and change. With newness often comes improved products, novelty replaces boredom and change brings innovation. The designer was searching for a bra that has all the above attributes.
- The designer looked into nature for inspiration. The imitation of living creatures such as jellyfish and octopuses’ bodies and tentacles provided some ideas in design decisions for this project.^{xliii}
- The positive features found in the six past designs are combined into the new “Octi” bra.
- The new creation could be used in swimwear (no padding or wires that will poke the wearer during swimming) and a bra that could be built into garments because the cup is designed for a bust and so eliminates the fear of breasts popping out of the cups.
- The new bra can be washed in the washing machine without fear of damaging it on account of the absence of an underwire.
- The new bra provides the required comfort, support and push-up effect for the female wearers.
- This unstructured push-up plunge bra was designed with optimum support in mind (for example, the breasts have not much space to move).
- The bra was designed to lift the breasts and add shape to the breast area.
- The designer wanted to create a bra for women who may choose to wear a push-up bra for a number of reasons (to wear a low-cut top, a bust top or for showing of cleavage).
- The bra was designed to boost and enhance the shape of a woman’s breasts.
- The designer worked with new technical fabrics, that provided the required fit and that worked ergonomically for the wearer’s body.

The designer followed a determined path to her new design by:

- Making technical drawings
- Drafting a basic block
- Making a first prototype
- Fitting on a model, pinning and drawing new design lines
- Evaluating and critiquing the design
- Creating an improved pattern: fitting on a model
- Evaluating and critiquing the design, and then back to technical drawing
- Making technical drawings of the new unstructured push-up plunge bra prototype as influenced by the experiments

The progress in *brassiere* development without the technological developments in the field of materials would have been stalled due to the nature of the garment and because its performance greatly depend upon the attributes of the fabric.

It also has not escaped the designer's notice that stretch fabrics have the added virtue of not requiring careful tailoring techniques. A really great (read: supportive, well-shaped and comfortable) bra will typically have a seam that runs right over the nipple; placing this seam and making it low-profile enough not to draw attention under clothing or to chafe is no easy feat and consumes many hours, both in the design and manufacturing stages.

However the scope of this project prevents a more detailed study of the field of fabric development.

Design and Development of the “Octi” Bra Prototype

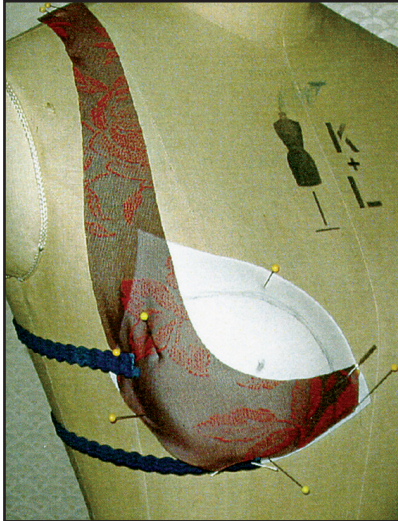


Figure 76: Development of a new cup

During this process medium-weight fabrics with two-way stretch were used



Figure 77: Testing the new cup on a model

Testing to ensure that the bust lifts without disturbing stress zones, i.e. lymph flow or “ouch zone,” and lifts-up without squashing the breasts.



Figure 78: More tests with the new cup

Working on the relationship between shoulder cutting and under-breast band to reduce the shoulder cutting.

Attachment of the back elastic used inline with BP (bust point) as per *Mary Tucek* patent and the designers own interpretation of *Mary Phelps's* bra design.



Figure 79: Front view of the test bra

The engineering of the breast produces a cup that allows a lift-up of the bust. Shoulder straps cut into shoulders as the lift-up improves -back to drawing board; strengthening at the under-bust is required to remove the shoulder-strap cutting.

When working on the model, fabric was minimised because accurate gravity could be observed



Figure 80: Work in progress

The under-bust shelf as per Arthur Garson. Lifting bust off the chest wall. Relationship between shoulder strap under-bust band and under cup.



Figure 81: Comparing the under-bust shelf with the pattern

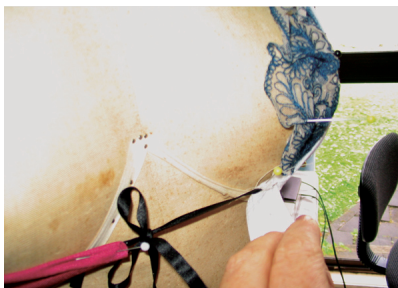


Figure 82: Work in progress

Work on the relationship between under-bust band and cup.

As with the under-bust band, the cup and the shoulder strap work together to create the push-up. The effect is that once one aspect is increased\ (e.g. the under-bust band) the other (the cup or shoulder strap) needs to be decreased in order to achieve balance and the required result - no shoulder cutting, no restriction of the lymphatic system, and to achieve the push-up effect.



Figure 83: Work on a panel inside the cup



Figure 84: The complicated construction is simplified and transferred to the mannequin



Figure 85: The finished product

A New Prototype of an Unstructured Bra

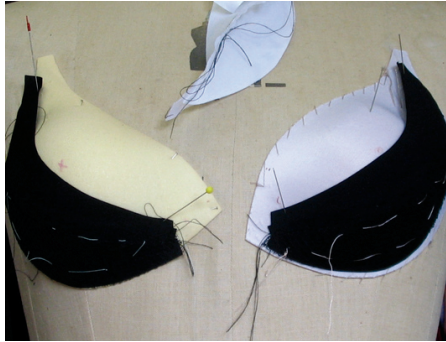


Figure 86: The under-bust panels are fitted



Figure 87: The inspiration for the new bra



Figure 88: Detail of the new cup – black bra



Figure 89: The final toile of the new prototype – black bra



Figure 90: Trims, sketches and fabric



Figure 91: The final garment – black bra

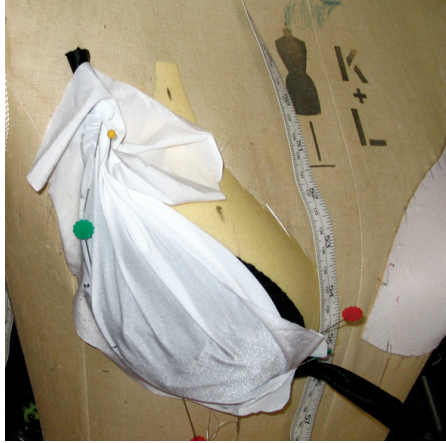


Figure 92: White bra changing the style



Figure 93: Assessing style, i.e. cup, under-bust band, shoulder-strap cutting



Figure 94: Work in progress



Figure 95: Thefinal garment - white bra

Chapter 7 -Evaluation

In order to evaluate the success or failure of the proposed prototype of the unstructured push up plunge bra design, it is helpful to establish the context in which the research is positioned and according to which standards it should be measured. As with many practice based design theses, this is made difficult by the interdisciplinary nature of the work; the human psychological factors that support this thesis inhabit a domain at the juncture of design, art and the construction engineering of garments.

As far as under-garments are concerned the new design concept fits within and expands on an established tradition in which new designs are themselves generative compositions from old designs; in the researcher's terms such systems are characterized by an "outer intervention" (in this case the bra wearers) whose forms make possible the articulation of yet other expressions in an "inner intervention" (for this work, the designer's design criteria). Distinguishing such inputs from the kinds of stimuli we conventionally call "inspiration" is largely a question of semantics and context; certainly the new prototype of the unstructured push-up plunge bra the designer proposes fits well within the usual definitions of art and design concepts.

The designer takes note of these concepts only insofar as they carry with them the implication that any given garment design is successful only if it is held to be useful and desirable by a broad base of consumers.

The designer is developing the "Octi" bra for an audience of general users. The final prototype is presented as a vehicle through which the designer has explored and presented a personal trial and error method of design practice, and suggests a new design solution for human-garment interaction. As Charles Baudelaire wrote in 1869, "*Are you sure that your story is the real one? But what does it matter what reality is outside myself, so long as it has helped me to live, to feel that I am, and what I am.*"^{xliv} Such a presentation includes the creative self-processes and self-discoveries of the designer herself.

In this sense this exegesis has a similarity to a concept of aboutteering craft (e.g. in which a designer originates specialized garments for others) and a commercial, “mass customisation” of populist manufacturing development (e.g. in which market-driven usability specialists refine the garment design for efficiency and to appeal to the latest style-seeking consumers). Thus, although the designer’s unstructured push-up plunge bra prototype may coincidently have potential marketability—an opinion drawn from the designer’s own observation that a number of bra wearers have enjoyed the new bra’s use -the designer leaves the new bra prototype evaluation to those who are customarily concerned with maximizing this sort of undergarment.

The designer submits that the new unstructured push-up plunge bra supporting this thesis should be able to support a populist performance evaluation by everyday users. In this context, the designer commissioned 10 female bra wearers to wear the prototype bra for a period of 200 hours each and to answer a comprehensive questionnaire that entails the personal evaluation of the bra design and its performance. The answers were analysed and collated in order to find the areas that require further investigation and development. The following table includes the evaluation questions, the resulting answers and the designer’s comments in relation to the findings.

Bra Questionnaire and Findings

Question	Key findings	Designer comments
Does the bra hold your breasts in the cup?	8 out of 10	Need to work on a bigger number of subjects to make it 10 out of 10
Does the bra compress the bust?	5 out of 10	To achieve push-up effect there has to be a percentage of compression
Does the bra have a push-up effect?	10 out of 10	The bra produces the desired push-up effect with every bra wearer
Do you consider the bra innovative?	7 out of 10	Some of the wearers commented that the bra is like a bikini or swimwear top
Would you prefer a front fastening bra?	8 out of 10	The bra can be designed both ways - front or back fastening
Does the design prevent riding-up (the bra moves up over the breast)?	8 out of 10	Different bust shapes - need an average
Can you wear it with low cut styled clothing?	10 out of 10	The bra is well suited to be worn with low-cut styled garments
Does it separate your bust?	10 out of 10	The wearers commented that the bra separates the breasts. The concept works here
Does the bra enhance your breasts?	10 out of 10	The bra does enhance the bust in in the opinion of all subjects-testers
Does the bra support your breasts?	8 out of 10	The cup and strap relationship is confirmed and this works well with most of the wearers
Would you prefer to have padding to fill in the under-cup?	5 out of 10	There is a need to use smaller panel cups to accommodate different breast shapes

Question	Key findings	Designer comments
Does the bra work without padding?	10 out of 10	The bra does create cleavage without the need to employ padding
Do the straps cut into the shoulders?	7 out of 10	In most cases the strap does not cut into the shoulders, depending on the shape and size of the breasts
Is the bra comfortable to wear?	10 out of 10	All wearers agreed that the bra was comfortable to wear
Does the fabric produce odour after prolonged wear?	10 out of 10	The bra fabric has not produced any unwanted odours after a long period of use
Does the fabric work ergonomically for the body?	10 out of 10	By using stretch fabric design ergonomics was achieved
Do any seams cause body friction?	10 out of 10	Seams did not interfere with body while wearers wore the bra
Do you consider the fabric to be suitable for the particular design?	8 out of 10	The relationship between fabric and pattern established and confirmed as functional and suitable for this design
How does the bra compare with the one that you usually wear?	7 out of 10	Most wearers found the bra comfortable but some room for improvement is still required. Explore the additional improvements needed to make the bra suitable for more wearers
Does the bra remove the discomfort from the areas that an underwire would normally cause?	10 out of 10	The bra does not cause any discomfort in the areas that underwire bras normally do
Does the bottom part of the bra squash breast flesh?	7 out of 10	This area can be changed according to bust shapes

Shape of the Bust

- For different size busts the bottom panel needs to be changed to either a bigger or smaller size due to the fact that the bra was modelled on one bust type (34B).
- One bra type might work for one bust but could not work on another (for example the Berlei bra might work for an apple-shaped breast but not for a pear-shaped breast). Therefore this bra could achieve uniformity for bust shapes if one of the panels of the cups was changed.
- For an older body the panels could be changed to accommodate sagging breasts.
- The new “*Octi*” bra is a performance bra; it is comfortable, has the desired support, and is healthy and aesthetic. The technique of construction/moulding could be used with different pattern-cutting styles. However in order for the bra to become commercial further testing is needed.

Performance of the Bra

The bra was comfortable due to the fact that the bust was contained within the cups; with no room to move within the cups.

From the above-collated findings the designer needed to ascertain whether the results from the wear and performance test provided answers to the designer's established design criteria for the "Octi" bra. These answers would enable the designer to determine whether the design needs further research, and designate the specified areas of such inquiry.

Summary of the Designer's Criteria and their Respective Achievements

Designers criteria	Designer's comments
<p>Elimination of underwire, padding or boning used in bra garments while creating the push-up effect as if the structural elements existed</p>	<p>The structure was successfully removed from the design and the push-up effect was still achieved. The selection of the right fabric for the prototype and the accurate pattern cutting ensured the success of this construction</p> <p>However, the designer questions the validity of results due to the fact that the prototype was made to measure. The prototype needs more testing on other busts to confirm the principles of this bra</p>
<p>Reduction of a heat build-up and reduction of restriction of the lymphatic system</p>	<p>No bra testers/wearers complained of excessive heat build-up. There were no reports of any of the marks that are usually associated with constriction of the lymphatic system</p> <p>The designer stipulates that giving a shelf-like shape to the cup reduces the constrictions that cause the interference with the lymph flow. More tests are required in this area to ascertain in detail how the new prototype bra affects the wearer's health</p>

<p>Elimination of the strap cutting into the shoulders by improved engineering/ construction techniques.</p>	<p>The strap cutting was considerably reduced. More tests are needed with different bust sizes to establish how they perform with the new garment</p> <p>The relationship between the cup, shoulder strap and under-bust band was correctly explored and it was proved that it affects the final design</p>
<p>Reduction of fabric used to create this innovative new bra by using a minimum of fabric</p>	<p>The designer found that the amount of fabric used in the creation of the prototype was determined by the relationship between the cup, shoulder strap and under-bust band plus the measurements of the bust volume. This proved to be very advantageous for the whole concept</p>
<p>Elimination of fabric allergy by utilising the latest body-friendly lingerie fabrics</p>	<p>The use of latest fabrics is recommended. The designer will need to do further research in this area</p>
<p>Create a fashionable bra desired to be worn by consumers.</p>	<p>The final design was created according to the latest bra styles and the testers/ wearers reacted very favourably to the style of the garment. This bra can be shaped in any style depending on the requirements of the customer.</p>



Figure 96: The “Octi” bra

Chapter 8 – Conclusion

For this project the designer has studied the historical, psychological, anatomical and technological developments of the bra to give her the insights to analyse, design and evaluate a series of bras (the *Mary Tucek* bra, the *Mary Phelps* bra, the *Arthur Garson* bra, the “*Cone-Shaped*” bra, the *Wonderbra* and the *Bioform* bra). The six bras have number of pros and cons and the designer has used the positives as some of the design criteria to inform her own design -the “*Octi*” bra.

From the evaluation of the “*Octi*” bra the designer established that the developed prototype provided solutions to the above-mentioned technological and human challenges that present themselves in a new bra design.

The “*Octi*” bra prototype was fashionable and comfortable, and it created a push-up effect without the use of structural elements. These findings confirmed that the results of the testing of the new bra prototype validated the designer’s concepts for this bra.

The designer decided that further investigations with relevance for this project should include the following:

1. The prototype needs more testing on other bust shapes to confirm that the principles that work for the “*Octi*” bra on a single specified shape work also on other bust shapes.
2. More tests are required in the health area to find out more about how the new prototype bra affects the health of the wearer.
3. Due to the fact that the “*Octi*” bra prototype was made to size 34B more tests are needed with different bust sizes to establish how they perform with the new garment.
4. Further research of the latest fabrics is recommended to find the most appropriate lingerie fabrics that can perform according to the designer’s criteria.

References

As far as the designer is aware no copyright or patent infringements have been committed. The designer wishes to acknowledge the following patents used in this research:

- Breast Supporter. No. 24.033. Henry S. Lesher. 1859.
- Corset Substitute. No. 40.907. Luman L. Chapman. 1863.
- Breast Supporter. No. 494.397. Marie Tucek. 1893.
- Backless Brassiere. No. 1.115.674. Mary Phelps Jacobs. 1914.
- Brassiere. No. 3.020.962. Arthur Garson. 1962.

Anscombe, I. (1984). *A woman's touch: women in design from 1860 to the present day*. New York: Viking Press.

Ash, J., & Wilson, E. (1992). *Chick thrills: fashion reader*. London: Pandora Press.

Balducci, L. (1929). *Clothing for women: selection and construction*, Philadelphia: J.B. Lippincott.

Batterberry, M., & A. (1997). *Fashion - the mirror of history*. New York: Greenwich House.

Baudot, F. (1999). *A century of fashion*. London: Thames & Hudson.

Brain, R. (1979). *The decorated body*. New York: Harper & Row.

Blau, H. (1999). *Nothing in itself: complexions of fashion*. Indianapolis: Indiana University Press.

Boucher, F., & Y. (1987). *20 000 Years of fashion: the history of costume and personal adornment*. New York: Harry N. Abrams.

Breward, C. (2003). *Fashion*. New York: Oxford University Press.

Brumberg, J. (1997). *The body project: an intimate history of American girls*. New York: Random House.

Calasibetta, C. (1986). *Essential terms of fashion*. New York: Fairchild Publications.

Caldwell, D. (1981). *And all was revealed*. New York: St. Martin's Press.

- Carter, E. (1977). *The changing world of fashion: 1900 to the present*. New York: Putnam.
- Devereaux, L. (1971). *Sew lovely lingerie*. Minneapolis: Sew Lovely Publications.
- Feldman, E. (1992). *Fashion of a decade - The 1990s. the pleasure of leisure*. London: B.T. Batsford.
- Ewing, E. (1971). *Fashion in underwear*. London: Batsford.
- Ewing, E. (1978). *Dress and undress: a history of women's underwear*. New York: Drama Book Specialists.
- Farrel-Beck, J., & Gau, C. (2002). *Uplift - the bra in America*. USA: University of Pennsylvania Press.
- Ferrill, M. (2003). *Marlies Dekkers - 33 propositions*. Schiedam, Netherlands: TDS printmaildata.
- Fontanel, B. (1997). *Support and seduction. The history of corsets and bras*. New York: Abradale Press & Harry N. Abrams, Inc.
- Gan, S. (1997). *Visionaire's fashion. Designers at the turn of the millenium*. London: Laurence King Publishing.
- Gousse, S., & Gousse, A. (1997). *Costume of new France from 1740 to 1760: a visual dictionary*. France: La Fleur de Lyse.
- Hawthorne, R. (1992). *Bras - a private view*. London: Souvenir Press.
- Joseph, M. (1998). *Essentials of textiles*. New York: Holt, Rinehart and Winston.
- Kadolph, S. (1998). *Textiles*. Upper Saddle River, N.J.: Merrill.
- Laver, J. (1945). *Taste and fashion from the French Revolution to the present day*. London: Harrap & Co.
- Nachtigall, W., & Bluchel, K. (2000). *Das grose buch der bionik*. Munich: MOHN Media.
- Martin, R. (1995). *Contemporary fashion*. Detroit: St James Press.
- Pedersen, S. (2004). *Bra. A thousand years of style, support and seduction*. UK: David & Charles.

Moustakis, C. (1990). *Heuristic research: design, methodology and applications*. London: Sage Publications.

O'Hara- Callan, G. (1998). *Dictionary of fashion and fashion designers*. London and New York: Thames & Hudson.

Ohara, G. (1986). *The encyclopedia of fashion*. New York: Thames & Hudson.

Payne, Bl., Geitel, W., & Farrell-Beck, J. (1992). *The history of costume: from ancient Mesopotamia through the twentieth century*. (2nd edn) New York: Harper Collins.

Piveteau, E. (2003). *Yearbook - lingerie 2004, objects of desire*. Switzerland: Editions Airelles.

Russell, J. (1986). *Jane Russell: an autobiography, my path, my detours*. Jove Books: New York.

Saint-Laurent, C. (1986). *A history of women's underwear*. London: Academy Editions.

Schon, D. (1983). *The reflective practitioner: how professionals think in action*. USA: Basic Books Inc.

Weiner, L. (1953). *The lovable story*. New York: Lovable Brassiere Company.

Yalom, M. (1997). *A history of the breast*. New York: Alfred A. Knopf.

Wilson, E. (1985). *Adorned in dreams. Fashion and modernity*. London: Virago Press and Los Angeles, Berkeley: University of California Press.

Lauersen, N., & Stukane, E. (1996). *The complete book of breast care*. New York: Ballantine.

Medical

Love, S. (1990). *Dr. Susan Love's breast book*. USA: Perseus Books.
<http://healthy.net/library/articles/schachter/breast.d.htm>

Singer, S., & Grismaier, S. (1995). *Dressed to kill: the link between breast cancer and bras*. USA: Avery Press.

http://www.swmed.edu/home_pages/library/cosumer/brastrap.htm

Go Ask Alice: *Columbia University's health education program*

<http://www.goaskalice.columbia.edu/1729.html>

Poole, O. (2000). *British study links bras to cysts and breast cancer: myths about breasts (that grown women still believe)*.

Home arts Network: Redbook.

<http://www.homearts.com/rb/health/97breaf1.htm>

Ashizawa, K., Sugane, A., & Gunji, T. (1990). *Breast form changes resulting from a certain brassiere*. Tokyo: Institute of Human Living Sciences - Otsuma Women's University.

Douglass, J. (1978). *The Lancet*. Los Angeles: Department of Internal Medicine - South California Medical Center, P. 1008.

Pain, J. (2000). *Pectoral girdle myalgia in women: a 5-year study in a clinical setting*. *Clinical Pathology*, 16(4):298-303.

Carlson, K., Eisenstat, S., & Ziporyn T. (1996). *The new Harvard guide to women's health*. Cambridge -Massachusetts and London -England: Harvard University Press.

Armstrong, H. J. (2000). *Draping for apparel design*. New York: Fairchild Publications.

Anthropological

Betzina, S. (2001). *Fast fit: easy pattern alterations for every figure*. Newtown: CT: Taunton Press.

Chapman, K. (2001). *Sizing up virtual fit technology*, From <http://www.techexchange.com/thelibrary/VirtualFit.html>. (March 2005)

A perfect bra: The best bra guide ever, Good Housekeeping, August 2000, pp. 43-45, 48.

Chafe, W. (1972). *The American woman: her changing social, economic, and political roles. Clothing selection: fashions,*

figures, fabrics, 1920 - 1970. New York: Oxford University Press.

Lee, H., Hong, K., & Eun - Ae, K. (2003). *Measurement protocol of women's nude breasts using a 3D scanning technique*.

Department of Clothing and Textiles, Chungnam National University, Yonsei University, Republic of Korea.

Hackos, J.T., & Redish, J.C. (1998). *User and task analysis for interface design*. New York: John Wiley & Sons.

Knight, J., & Jefsiountine, M. (2002). *Understanding the user: research methods to support the digital media designer*. Research Issues in Art, Design and Media, Issue No.3.

Mayer, K. (2004). *Kettenwirk praxis*. Germany: Textilmachinenfabric.

McConville, J.T. ed.(1986). *Anthropometric fit testing and evaluation*. Performance of Protective Clothing:ASTM STP 900 (pp. 556-568).

Perry, P., ed. (1972). *The Vogue sewing book of fitting, adjustments, and alterations*. New York: Butterick Fashion Marketing Company.

Fox Ruth, design director for Rigby & Peller, corsetiere to the Queen, Vogue Magazine (1998).

Yanagi, A.T., ed. (1994). *Fitting your figure*. Newtown: Taunton Press.

Zangrillo, F. L. (1990). *Fashion design for the plus size*. New York: Fairchild Publications.

Internet Websites -Bibliography

WGSN news service. *Lingerie and swimwear trends. (2004).*
Retrieved March 20/2005 from:
http://www.wgsn-edu.com/members/trends-info/fast-track/features/ti2004aug18_010481

CoolMax ALTA. (n.d.). Retrieved March 22, 2005 from:
<http://www.fabriclink.com/pk/coolmaxalta/home.html>

WGSN news service. *Nike introduces football shirt innovation.*
(2002). Retrieved February 1, 2005 from:
http://www.wgsn-edu.com/members/active-market/features/am2002feb22_003309?.htm

WGSN news service. *Adidas launches new football kit. (2001).*
Retrieved February 1, 2005 from:
http://www.wgsn-edu.com/members/active-market/features/am2001nov29_002896

NASA STI. *Covered in comfort. (2004).* Retrieved June 16, 2005
from:
http://www.techbriefs.com/spinoff/Spinoff2004/ch_1.html

Bra sensor. (n.d.) Retrieved June 15, 2004 from:
http://www2.marksandspencer.com/storeplus/foodnfeatures/innovations/bra_sensor.htm

Underwear, undergarments; definition of clothing. (n.d.)
Retrieved May 6, 2005 from:
http://www.apparelsearh.com/Definitions/Clothing/underwear_definition.htm

Lingerie from Eschler. (n.d.) Retrieved March 22, 2005 from:
http://www.eschler.com/t_lingerie_e.htm

Not a bomber bra. (n.d.) Retrieved December 2, 2004 from:
<http://title9sports.com/shopping/product/detailmain.jsp?itemID=89&itemType=P.htm>

Slimish. (n.d.) Retrieved March 22, 2005 from:
<http://www.fujiibo.co.jp/us/seihin/slimish/>

Marie Tucek patent. (n.d.) Retrieved April 20, 2004 from:
<http://www.home.nycap.rr.com/useless/brassiere/bra1.jpg>

Mary Phelps patent. (n.d.) Retrieved April 20, 2004 from:
<http://www.home.nycap.rr.com/useless/brassiere/bra2.jpg>

Patents: Henry S Lesher; Arthur Garson.(n.d.). Retrieved April 21, 2004 from:
http://www.edinformatics.com/inventions_inventors/brassiere.htm

www.inventors.about.com/library/weekly/aa042597.htm

Smith, Joanna. *Breast health*, (n.d.) Retrieved December 10, 2004 from:
<http://www.all-natural.com/dressed.html>

Thurman, Laurence. *Bra and breathing*, (2001). Retrieved December 10, 2004 from:
<http://www.breathing.com/articles/brassieres.htm>

Figure analyzer. (n.d.) Retrieved January 12, 2005 from:
<http://www.wacoal-america.com/aboutwacoal.html>

Adams, Peter. *Understanding sizing techniques in lingerie construction.* (1994). Retrieved September 4, 2004 from:
<http://www.sizes.com/people/brassieres.htm>

Lee, H., Hong, K., & Eun - Ae, K. (2003). *Mass customization.* Retrieved April 8, 2005 from:
http://www.rapidform.com/success/success_6_2.htm

Farrrel-Beck, Jane. (n.d.). *Details.* Retrieved March 3, 2005 from:
<http://www.fcs.iastate.edu/tc/faculty/jfarell.asp>

Guides, fabrics, wovens, polyester. (n.d.) Retrieved March 22, 2005 from:
<http://www.informat.com/guides/polyester.html>

Jobling, Andrew. (2004). *Seasonal influences fabrics.* Retrieved April 15, 2005 from:
http://www.wgsn-edu.com/members/active-market/seasonal/am2004mar18_009246

Elan Textiles. (n.d.). Retrieved June 14, 2005 from:
http://www.elantex.com.tw/elan_e_products.htm

McRobbie, Angela. *British fashion design*, (1998). Retrieved October 1, 2004 from:
<http://www.lasenza.co.uk/history.asp>

Bra history. (n.d.) Retrieved October 1, 2004 from:
<http://www.brashop.co.nz/brahistory.htm>

Steward, John. *Engineering principles in bra making*. (1984). Retrieved December 12, 2004 from:
<http://www.ruralamerica.net/~aster/boudoir/overflow/engineer.htm>

Push-up bra history. (n.d.) Retrieved January 10, 2005 from:
http://www.bikiniscience.com/costumes/soutien-gorge_SS/push-up_S/push-up.html

In search of a comfortable bra. (n.d.) Retrieved March 19, 2005 from:
<http://www.briefing.net/search/wcpdemo/1040.html#a16>

Bioform bra (2002). Retrieved September 12, 2004 from:
http://www.autospeed.com/cms/A_1260/printArticle.html

Bra history. (n.d.) Retrieved March 29, 2005 from
<http://www.museumofcostume.co.uk>

Bra history. (n.d.). Retrieved December 12, 2004 from:
<http://www.fashion.net>

Bra styles. (n.d.) Retrieved December 17, 2004 from:
<http://www.style.com>

Bra history. (n.d.) Retrieved January 18, 2005 from:
<http://costumegallery.com>

Rodgers, Brett. *Fashion Photography*. (1991). Retrieved February 10, 2005 from:
<http://www2.fashionweb.co.uk/fashionweb>

Bra styles. (n.d.) Retrieved April 23, 2005 from:
<http://www.fashionangel.com>

Bras. (n.d.) Retrieved August 10, 2004 from:
<http://vogue.co.uk>

History of bra. (n.d.) Retrieved December 12, 2004 from:
<http://costumesocietyamerica.com>

How Bali started. (n.d.) Retrieved August 28, 2004 from:
www.balicompany.com

www.designnews.com/article/CA108341.html

Lymphatic drainage of the breast. (n.d.). Retrieved October 20, 2004 from:
http://www.ahbras.com/A_Breasts_LymphSystem.jpg

Bras after 1950. (n.d.) Retrieved August 29, 2004 from:
www.fashion-era.com/bras_after_1950.htm

Bra and cancer risk. (n.d.) Retrieved October
www.cancerhelp.org.uk/help/default.asp?page=3282

Lymph nodes and bra. (n.d.) Retrieved October 23, 2004 from:
www.breastcancer.org/tre_surg_whatlymph.html

Bra and different breasts shapes. (n.d.) Retrieved October 23, 2004 from:
www.007b.com/breast_gallery.php

Wonderbra. (n.d.) Retrieved November 2, 2004 from:
<http://inventors.about.com/library/inventors/blbra.htm#wonderbra>

Useless patents. (n.d.) Retrieved November 12, 2004 from:
<http://inventors.about.com/gi/dynamic/offsite.htm?site=http://home.nycap.rr.com/useless/brassiere/index.html>

Bra choices. (n.d.) Retrieved November 12, 2004 from:
<http://www2.victoriasscret.com/commerce/application?namespace=shoppingBag&origin=viewBag.jsp&event=link.viewBag>

History of Cadolle. (n.d.) Retrieved March 19, 2005 from:
<http://www.cadolle.com>

http://encyclopedia.worldsearch.com/herminie_cadolle.htm

Breward, Christopher. *Working paper.* (2002). Retrieved May 10, 2005 from:
http://www.consume.bbk.ac.uk/working_papers/Breward%20Working%20Paper%20.doc

Table of Figures

Every effort has been made to trace the copyright holders. The designer apologises for any unintentional omissions.

Figure 1 Cleavage and buttocks	21
<i>Bottoms up</i> , Photograph, 2004. Corbis: Devon.	
Figure 2: Cretan woman's	22
<i>Cretan woman</i> , Marble sculpture, 2500 BC. Archaeological Museum: Ephesus.	
Figure 3: Roman athletes wearing bra bands	22
<i>Roman athletes</i> , Mosaic, 100 AD. The Art Archive: Orti.	
Figure 4: Catherine de Medici	22
Thomas de Keyser, <i>Catherine de Medici</i> . 1630. Musee de Louvre, Paris	
Figure 5: Napoleonic fashion	23
Jaques-Louis David. <i>Madame Tolloen</i> , Oil Painting, 1795. Bulloz. Paris.	
Figure 6: Henry S. Lesher's first bra patent	24
<i>Henry S. Lesher first patent bra</i> , Digital Image, 1859. Edinformatics. USA.	
Figure 7: Luman Chapman's patent	24
<i>Luman Chapman's patent</i> , Digital Image, 1863. Edinformatics. USA.	
Figure 8: 1920s flat chest fashions	26
<i>1920s fashion</i> , Print, 1929. Hulton-Deutsch Collection. Berlin.	
Figure 9: Jane Russell -in <i>The Outlaw</i>	26
<i>Jane Russell - The Outlaw</i> , Movie, Photograph, 1940. United Artists, Los Angeles.	
Figure 10: Madonna wearing the "bullet bra"	27
Neil Preston. <i>Madonna wearing the "bullet bra"</i> , Photograph, 1990. Corbis.	
Figure 11: Wacoal Silhouette Analyser	30
<i>Wacoal Silhouette Analyser</i> , Digital Image, 2000. Wacoal. Japan.	
Figure 12: Designer's method of measuring the breast	30
Lize Niemczyk. <i>Designer's method of measuring the breast</i> , Drawing, 2005. Auckland.	
Figure 13: Medical bust -side view	32
<i>Medical bust -side view</i> , Illustration, 1996. Ballantine Publications. NY. P.56.	
Figure 14: Front View of breast	33
<i>Front view of breast</i> , Illustration, 1996. Ballantine Publications. NY. P.56.	
Figure 15: Side View of breast	34
<i>Side view of breast</i> , Illustration, 1996. Ballantine Publications. NY. P.57.	
Figure 16: Product evaluation method	47
Lize Niemczyk, <i>Product evaluation method</i> , Graph, 2004.	
Figure 17: Mannequin number 1	55
Lize Niemczyk, <i>Mannequin number 1</i> , Digital Photograph, 2004.	
Figure 18: A mould made of bra cup fabric and silicone	56
Lize Niemczyk, <i>A mould made of bra cup fabric and silicone</i> , Digital Photograph, 2004.	
Figure 19: Measuring Systems	57
Lee, H., Hong, K., & Eun Ae, K., Measuring systems, 2003. <i>In measurement protocol of woman's nude breast using 3D scanning techniques</i> . Yonsei University. Republic of Korea. P. 53.	

Figure 20: A mesh mould of the breasts	57
Lee, H., Hong, K., & Eun Ae, K., Measuring systems, 2003. <i>In measurement protocol of woman's nude breast using 3D scanning techniques</i> , Yonsei University. Republic of Korea. P. 53.	
Figure 21: Mannequin number 1 – view from the top	58
Lize Niemczyk, <i>Mannequin number 1 – view from the top</i> , Digital Photograph. 2004.	
Figure 22: Breast measurement reference points	58
Lee, H., Hong, K., & Eun Ae, K., <i>Breast measurement reference points – front and side view</i> , 2003. <i>In measurement protocol of woman's nude breast using 3D scanning techniques</i> , Yonsei University. Republic of Korea. P. 54.	
Figure 23: Breast measurement points	59
Lize Niemczyk, <i>Breast measurement points</i> , Digital Photograph. 2004.	
Figure 24: Mary Tucek bra patent	61
<i>Mary Tucek bra patent</i> , Scanned Digital Image, of 1893 original. Edinformatics. USA	
Figure 25: The start of the toile	62
Lize Niemczyk, <i>The start of the toile</i> , Digital Photograph. 2004.	
Figure 26: The toile completed. The cup shape is at a 45-degree angle	62
Lize Niemczyk, <i>The toile completed. The cup shape is at a 45-degree angle</i> , Digital Photograph, 2004.	
Figure 27: Two thin attachments and elastic keep this bra firm on the body	62
Lize Niemczyk, <i>Two thin attachments and elastic keep this bra firm on the body</i> , Digital Photograph, 2004.	
Figure 28: Front view of the toile	62
Lize Niemczyk, <i>Front view of the toile</i> , Digital Photograph, 2004.	
Figure 29: The bust point and the attachments are on the same level	63
Lize Niemczyk, <i>The bust point and the attachments are on the same level</i> , Digital Photograph, 2004.	
Figure 30: Working on frills	63
Lize Niemczyk, <i>Working on frills</i> , Digital Photograph, 2005.	
Figure 31: Final design with embellishments	63
Lize Niemczyk, <i>Final design with embellishments</i> , Digital Photograph, 2005.	
Figure 32: Designer's version of the Mary Tucek bra plus matching briefs – front view	63
Lize Niemczyk, <i>Designer's version of the Mary Tucek bra plus matching briefs – front view</i> , Digital Photograph, 2005.	
Figure 33: Designer's version of the Mary Tucek bra plus matching briefs – back view	64
Lize Niemczyk, <i>Designer's version of the Mary Tucek bra plus matching briefs – back view</i> , Digital Photograph, 2005.	
Figure 34: Close-up of the designers interpretation of the Mary Tucek bra	64
Lize Niemczyk, <i>Close-up of the designers interpretation of the Mary Tucek bra</i> , Digital Photograph, 2005.	
Figure 35: Summary of the Mary Tucek bra	65
Lize Niemczyk, <i>Product evaluation method</i> , Graph, 2004.	
Figure 36: The inspiration for the Mary Tucek bra	66
Antarctic adventures, <i>Sea life</i> . 2000. <i>In under-ice jellyfish</i> , NY, Media. P. 62.	
Figure 37: Detailed view of the Mary Tucek bra cup	67
Lize Niemczyk, <i>Detailed view of the Mary Tucek bra cup</i> , Digital Photograph, 2005.	
Figure 38: Designer's version of the Mary Tucek bra	69
Lize Niemczyk, <i>Designer's version of the Mary Tucek's bra</i> , Digital Photograph, 2005.	

Figure 39: Mary Phelps bra patent	71
<i>Mary Phelps bra patent</i> , Digital Image, 11914. Edinformatics. USA.	
Figure 40: The toile takes shape	72
<i>Lize Niemczyk, The toile takes shape</i> , Digital Photograph, 2004.	
Figure 41: The toile being assessed for fit and function	72
<i>Lize Niemczyk, The toile being assessed for fit and function</i> , Digital Photograph, 2004.	
Figure 42: The reinterpreted version of the Mary Phelps bra	72
<i>Lize Niemczyk, The reinterpreted version of the Mary Phelps bra</i> , Digital Photograph, 2004.	
Figure 43: Bra fabric minimized	72
<i>Lize Niemczyk, Bra fabric minimized</i> , Digital Photograph, 2004.	
Figure 44: Raw edges finished	73
<i>Lize Niemczyk, Raw edges finished</i> , Digital Photograph, 2004.	
Figure 45: The toile being tested for shoulder cutting and lift-pressure on the bust and around the torso	73
<i>Lize Niemczyk, The toile being tested for shoulder cutting and lift-pressure on the bust and around the torso</i> , Digital Photograph, 2004.	
Figure 46: The toile testing	73
<i>Lize Niemczyk, The toile testing</i> , Digital Photograph, 2005.	
Figure 47: The final toile	73
<i>Lize Niemczyk, The final toile</i> , Digital Photograph, 2005.	
Figure 48: Finished - the designers interpretation of the Mary Phelps bra	75
<i>Lize Niemczyk, Finished - the designers interpretation of the Mary Phelps bra</i> , Digital Photograph, 2005.	
Figure 49: Summary of the Mary Phelps bra	76
<i>Lize Niemczyk, Summary of the Mary Phelps bra</i> , Table, 2005.	
Figure 50 The inspiration for the Mary Phelps bra	77
<i>Encarta, Jellyfish</i> , 2000. Encarta, Microsoft.	
Figure 51: The final design of the Mary Phelps bra with lace overlay	78
<i>Lize Niemczyk, The final design with of the Mary Phelps bra with lace overlay</i> , Digital Photograph, 2005.	
Figure 52: Arthur Garson's patent	81
<i>Arthur Garson's patent</i> , Digital Image, 1962. Edinformatics. USA.	
Figure 53: The toile	82
<i>Lize Niemczyk, The toile</i> , Digital Photograph, 2004.	
Figure 54: Pattern – side view	82
<i>Lize Niemczyk, Pattern –side view</i> , Digital Photograph, 2004.	
Figure 55: Pattern – front view	82
<i>Lize Niemczyk, Pattern – front view</i> , Digital Photograph, 2004.	
Figure 56: Comparing patterns	83
<i>Lize Niemczyk, Comparing patterns</i> , Digital Photograph, 2004.	
Figure 57: Unstructured version	83
<i>Lize Niemczyk, Unstructured version</i> , Digital Photograph, 2005.	
Figure 58: Technical structured version	83
<i>Lize Niemczyk, Technical structured version</i> , Digital Photograph, 2005.	
Figure 59: Back view of the bra version	84
<i>Lize Niemczyk, Back view of the bra version</i> , Digital Photograph, 2005	
Figure 60: Summary of the Arthur Garson bra	85
<i>Lize Niemczyk, Summary of the Arthur Garson bra</i> , Table, 2005	
Figure 61: Lana Turner	87
<i>Laszlo Willinger, Lana Turner</i> , Photograph, 1937. MGM, Los Angeles.	
Figure 62: Whirlpool stitching	87

Alain Pele, <i>Whirlpool stitching</i> , Drawing, 1960. Paprika. P. 79.	
Figure 63: Start of the toile	89
Lize Niemczyk, <i>Start of the toile</i> , Digital Photograph, 2005.	
Figure 64: Continuation of the toile 2	89
Lize Niemczyk, <i>Continuation of the toile</i> , Digital Photograph, 2005.	
Figure 65: Bra cones	89
Lize Niemczyk, <i>Bra Cones</i> , Digital Photograph, 2005.	
Figure 66: Final drawing	89
Lize Niemczyk, <i>Final Drawing</i> , Drawing, 2005.	
Figure 67: Summary of the Cone-Shaped bra	91
Lize Niemczyk, <i>Summary of the Cone-Shaped bra</i> , Table. 2005	
Figure 68: Designer's interpretation of the Cone-Shaped bra	92
Lize Niemczyk, <i>Designer's interpretation of the Cone-Shaped bra</i> , Digital Photograph, 2005.	
Figure 69: Designer's inspiration for the bra	92
Encarta, <i>Sea Life</i> , 2000. Microsoft.	
Figure 70: Final version of the Cone-Shaped bra	93
Lize Niemczyk, <i>Final Version of the Cone-Shaped bra</i> , Digital Photograph, 2005.	
Figure 71: The Wonderbra	95
Wonderbra, Photograph, 1998, Wonderbra for Sara Lee Intimates. USA.	
Figure 72: Summary of the Wonderbra	97
Lize Niemczyk, <i>Summary of the Wonderbra</i> , Table. 2005	
Figure 73: Bioform bra	99
<i>Bioform bra</i> , Photograph, 2002. Rapidform. London.	
Figure 74: The "internal keel" as it appears on the body	100
<i>the "internal keel" as it appears on the body</i> , Photograph, 2002. Rapidform. London.	
Figure 75: Summary of the Bioform bra	101
Lize Niemczyk, <i>Summary of the Bioform bra</i> , Table. 2005	
Figure 76: Development of a new cup	107
Lize Niemczyk, <i>Development of a new cup</i> , Digital Photograph, 2004.	
Figure 77 Testing the new cup on a model	107
Lize Niemczyk, <i>Testing the new cup on the model</i> , Digital Photograph, 2004.	
Figure 78: More tests with the new cup	108
Lize Niemczyk, <i>More tests with the new cup</i> , Digital Photograph, 2004.	
Figure 79: Front view of the test bra	108
Lize Niemczyk, <i>Front view of the test bra</i> , Digital Photograph, 2005.	
Figure 80: Work in progress	109
Lize Niemczyk, <i>Work in progress</i> , Digital Photograph, 2005.	
Figure 81: Comparing the under-bust shelf with the pattern	109
Lize Niemczyk, <i>Comparing the under-bust shelf with the pattern</i> , Digital Photograph, 2004	
Figure 82: Work in progress	109
Lize Niemczyk, <i>Work in progress</i> , Digital Photograph, 2004.	
Figure 83: Work on a panel inside the cup	110
Lize Niemczyk, <i>Work on a panel inside the cup</i> , Digital Photograph, 2005.	
Figure 84: The complicated construction is simplified and transferred to the mannequin	110
Lize Niemczyk, <i>The complicated construction is simplified and transferred to the mannequin</i> , Digital Photograph, 2005.	
Figure 85: The finished product	111
Lize Niemczyk, <i>The finished Product</i> , Digital Photograph, 2005.	
Figure 86: The under-bust panels are fitted	112

Lize Niemczyk, <i>The under bust panels are fitted</i> , Digital Photograph, 2005.	
Figure 87: The inspiration for the new bra	112
Lize Niemczyk, <i>The inspiration for the new bra</i> , Digital Photograph, 2005.	
Figure 88: Detail of the new cup – black bra	112
Lize Niemczyk, <i>Detail of the new cup – black bra</i> , Digital Photograph, 2005	
Figure 89: The final toile of the new prototype – black bra	112
Lize Niemczyk, <i>The final toile of the new prototype – black bra</i> , Digital Photograph, 2005.	
Figure 90: Trims, sketches and fabric	112
Lize Niemczyk, <i>Trims, sketches and fabric</i> , Digital Photograph, 2005.	
Figure 91: The final garment – black bra	113
Lize Niemczyk, <i>The final garment – black bra</i> , Digital Photograph, 2005.	
Figure 92: White bra changing style	114
Lize Niemczyk, <i>White bra changing style</i> , Digital Photograph, 2005.	
Figure 93: Assessing style, i.e. cup, under-bust band, shoulder-strap cutting	114
Lize Niemczyk, <i>Assessing style, i.e. cup, under-bust, shoulder-strap cutting</i> , Digital Photograph, 2005.	
Figure 94: Work in progress	114
Lize Niemczyk, <i>Work in progress</i> , Digital Photograph, 2005.	
Figure 95: The final garment - white	115
Lize Niemczyk, <i>The final garment -white</i> , Digital Photograph, 2005.	
Figure 96: The “Octi” bra	125
Lize Niemczyk, <i>The “Octi” bra</i> , Digital Photograph, 2005.	

Endnotes

ⁱFontanel, B. (1992) *Support and seduction – A history of corsets and bras*. NY: Abradale Press. (p.90).

ⁱⁱChafe, W. H. (1972). *The american woman: her changing social, economic, and political roles. Clothing selection: fashions, figures, fabric - 1920 – 1970*. New York: Oxford University Press. (p. 66).

ⁱⁱⁱMorris, D. (1960). *The Naked Ape*. UK: Bantam. (p. 34).

^{iv}Pedersen, S. (2004). *Bra. A thousand years of style, support and seduction*. UK: David and Charles. (p.11)

^vDubois, C. (1857). *An examination of five plagues: corsets, tobacco, gambling, strong drink and illegal speculation*. London: York Bros.

^{vi}<http://www.lasenza.co.uk/history.asp> (July 2004).

^{vii}Farrel-Beck, J. & Gau, C. (2002). *Uplift – the bra in america*. USA: University of Pennsylvania Press. (p. 57).

^{viii}US Patent 40 907,15 December 1863, Luman L. Chapman.

^{ix}Farrel-Beck, J. & Gau, C. (2002). *Uplift – the bra in america*. USA: University of Pennsylvania Press. (p. 54).

^xhttp://www.consume.bbk.ac.uk/working_papers/Breward%20Working%20Paper%20.doc (p.203).

^{xi}Pedersen, S. (2004). *Bra. A thousand years of style, support and seduction*, UK: David and Charles. (p.101).

^{xii}As spoken by Ruth Fox, design director for Rigby & Peller, corsetiere to the Queen – Vogue Magazine (Nov, 1999)

^{xiii}Department of Statistics New Zealand 2004.

^{xiv}*A Perfect Bra: The Best Bra Guide Ever*. (2000). Good Housekeeping. (p.43-45, 48).

^{xv}http://www.rapidform.com/success/success_6_2.htm (August 2004).

^{xvi}<http://www.sizes.com/people/brassieres.htm> (September 2004).

^{xvii}Saint Laurent, C.(1986). *A History of Women's Underwear*. London: Harper & Row. (p. 56).

^{xviii}<http://www.wacoal-america.com/aboutwacoal.html> (August 2004).

^{xix}Lee, H., Hong, K., & Eun - Ae, K. (2003). *Measurement protocol of women's nude breasts using a 3D scanning techniques*. Department of Clothing and Textiles, Chungnam National University, Yonsei University, Republic of Korea.

^{xx}Love, S. (1990). *Dr. Susan Love's breast book*, USA: Perseus Books. (p. 75).

^{xxi}<http://www.all-natural.com/fibrocys.html> (november 2004).

^{xxii}Love, S. (1990). *Dr. Susan Love's breast book*. USA:Perseus Books. (p. 75).

^{xxiii}Dr Douglas, J. M. (November 4, 1978). *The Lancet*, .The breast and bras. Department of Internal Medicine - S. Calif. Permanente Med. Center, Los Angeles California. USA. (p.101).

^{xxiv}Hsieh, C. C. & Trichopoulos, D. (1991). *Breast size, handedness and breast cancer risk*. USA: Harvard University. (p.131-5).

^{xxv}Ashizawa, K., Sugane, A., & Gunji, T. (1990). *Breast form changes resulting from a certain brassiere*. Journal of Hum Ergol- Institute of Human Living Sciences, Otsuma Women's University.

^{xxvi}<http://www.selfstudycenter.org/> (August 2004).

^{xxvii}<http://www.all-natural.com/fibrocys.html> (September 2004).

^{xxviii}Dixon, J. M., McDonald, C., Elton, R. A., & Miller W. R. (1999). *Risk of breast cancer in women with palpable breast cysts: a prospective study*. Edinburgh Breast Unit - Western General Hospital. UK: Lancet. (p. 22:353 (9166):1742-5).

^{xxix}Cawthorne, S. M.D. (2000) Surgeon at Frenchay Hospital, Bristol, England and Prof. Robert Mansel, M.D., Surgery Dept. Head, University of Wales Medical School, Cardif, Wales.

^{xxx}Ryan, E. L. (2000). *Pectoral girdle myalgia in women: a 5-year study in a clinical setting*. UK: Clinical Pain, (p. 16 (4): 298-303).

^{xxxi}Last month delivered a scholarly paper on the brassiere at the annual conference of the Society for the History of Technology in Toronto.

^{xxxii}US Patent 494 397, 28 March 1893, Marie Tucek.

^{xxxiii}The “Bullet Bra” was based on an antique breastplate worn by Italian soldiers, intimidating and protective at one and the same time.

^{xxxiv}Yalom, M. (1997). *A history of the breast*. New York: Alfred A. Knopf. (p. 54).

^{xxxv}Schön, D. E.(1983). *The reflective practitioner: how professionals think in action*. USA: Basic Books Inc. (p. 102).

^{xxxvi}Strauss,A. & Corbin,J.M.(1990).*Basics of qualitative research : techniques and procedures for developing grounded theory*. 92nd ed). UK: Sage Publications. (p. 123).

^{xxxvii}Saint Laurent, C.(1986). *A History of Women's Underwear*. London: Harper & Row. (p.67).

^{xxxviii}Lee, H., Hong, K., & Eun -Ae, K. (2003). *Measurement protocol of women's nude breasts using a 3D scanning techniques*. Department of Clothing and Textiles, Chungnam National University, Yonsei University, Republic of Korea.

^{xxxix}Hawthorne, R. (1992). *Bras - a private view*. London: Souvenir Press. (p. 79).

^{xl}Yalom, M. (1997). *A history of the breast*. New York: Alfred A. Knopf. (p. 34).

^{xli}Ewing, E. (1978). *Dress and undress: A history of women's underwear*. New York: Drama Book Specialists. (p.45).

^{xlii}www.autospeed.com/A_1260/cms/article.html. (September 2004).

^{xliii}Nachtigall W. & Bluchel, K. G. (2000). *Das grose buch der bionik*. Munchen; MOHN Media.

^{xliv}Fontanel, B.(1992). *Support and seduction - A history of corsets and bras*. NY:Abra-dale Press. (p. 134).

