# EMPOWERING DESIGN ATTRIBUTES FOR BODY-WORN REHABILITATION DEVICES
# A CASE STUDY: FROM A SHOULDER SUPPORT FOR WOMEN TO SHOULDERWEAR

By

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**ABSTRACT**

Empowerment is an important approach in physiotherapy, and is shown to have many benefits for clients in their rehabilitation process. This thesis considers whether the concept of empowerment can be extended from physiotherapy to the design of body-worn rehabilitation products. This study reviews current developments in the design of rehabilitation products as well as design theories that relate to empowerment. A research probe was conducted in order to understand if body-worn or carried artifacts are understood by wearers to impart a sense of empowerment, and what specific design attributes might most effectively convey empowerment. Findings were analyzed and documented as empowerment principles. A case study was developed to explore the application of these empowerment principles to the design of a shoulder support for women. This case study includes functional development through biomimetic design in order to determine baseline functional specifications. In the development of the product, research findings influenced the design such that it evolved from the conventional rehabilitation approach of "shoulder support" to a collection of concepts for S*houlderwear*. This thesis demonstrates that feeling empowered is important to wearers of rehabilitation products, and that empowerment guidelines can be successfully applied to design artifacts.

**Keywords:** Empowerment, Biomimetic Design, Shoulder Stabilization, Physiotherapy, Rehabilitation, Design Research, Research Probe, Fashion, Anatomy, Biomechanics, Physical Disability, Shoulderwear.

## TABLE OF CONTENTS

## LIST OF FIGURES

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## DEFINITION OF KEY TERMS

***The definitions in bold the table below were provided by the Oxford Dictionaries Online and the terms in italics are working definitions for the purposes of this thesis paper.***

| Term | Definition |
|---|---|
| Anatomy | the branch of science concerned with the bodily structure of humans |
| Authority | the power or right to give orders and make decisions |
| Autonomy | the right or condition of self-govern |
| Biomechanics | the study of the mechanical laws relating to the movement or structure of the human body |
| Biomimetics | study of the structure and function of biological systems as models for the design and engineering of materials and machines. |
| Dignity | the state or quality of being worthy of honour or respect |
| **Empowerment** | **giving (someone) the authority or power to do something: "make (someone) stronger and more confident", especially in controlling their life and claiming their rights** |
| Enable | to give (someone) the authority or means to do something |
| Physical Disability (short term) | a temporary physical condition that limits a person's movements, senses, or activities - eventual recovery to within normal limits |
| Physical Disability (long term) | a physical condition that limits a person's movements, senses, or activities in some capacity indefinitely |
| Physical Therapy | the treatment of disease, injury, or deformity by physical methods such as exercise, heat treatment, and massage rather than by drugs or surgery. |
| Rehabilitation Device (assistive device) | any device designed or adapted to help people with physical disorders to perform actions, tasks, and activities |
| Self-Identity | the recognition of one's potential and qualities as an individual, especially in relation to social context |

| Term | Definition |
|---|---|
| *Client-Centered Treatment* | *a physiotherapy approach that addresses the specific needs of clients on an individual basis while maintaining their autonomy and dignity* |
| *Functional Empowerment* | *gaining a sense of empowerment when a tool or device works reliably and effectively* |
| *Private Empowerment* | *gaining a sense of empowerment without any positive attention from others* |
| *Public Empowerment* | *gaining a sense of empowerment from the positive attention of others* |
| *Sensory Empowerment* | *gaining a sense of empowerment from physical or emotional experiences related to tactile qualities* |
| *Shoulderwear* | *a fashionable shoulder support for women* |
| *Shoulder Instability* | *a reduced ability for the ball to remain secure against the socket of the shoulder joint* |
| *Shoulder Stabilization* | *increasing the security of the ball against the socket of the shoulder joint* |
| *A Shoulder Support* | *an assistive device that aids in securing the ball against the socket of the shoulder joint at rest and during movement* |
| *A Shoulder Brace* | *a device that immobilizes the shoulder joint to prevent movement* |

# 1.0 PHYSIOTHERAPY AND DESIGN OPPORTUNITIES

## 1.1 Inspiration

> *"Makers (designers) do not so much see what is there physically in front of them but rather see what might be there, what could become of what is there before them."*
>
> *-Cameron Tonkinwise (6)*

As a physiotherapy student in the second year of my studies I recall a guest speaker sharing his experience of living with a prosthetic lower leg. I was struck by his excitement as he described how the prosthetic leg enabled him to mountain bike, hike and perform essentially all the activities he participated in prior to the amputation of his lower leg. The guest speaker said he liked the hi-tech look and the image it projected to others. He also reported he liked displaying the mechanical components of the prosthetic leg rather than covering over the prosthetic with a flesh coloured moulding. The speaker stated feeling especially proud of his latest prosthetic leg because his feedback and input to his technician led to improvements over the last version. In fact, he had reportedly gone through three sets of prosthetic legs and was currently "test driving" the fourth version.

The experience of this speaker resonated with me because it demonstrated how an *assistive device* was essentially being described as *empowering*. In my current physiotherapy practice I continue to be aware of design's influence on clients, in particular, how rehabilitation devices influence the feelings of clients in private and in the public domain. Clients often report their experiences with a rehabilitation device as positive or negative which I relate to as empowering or disempowering experiences because of the impact these experiences have on their quality of life. I have questioned how a rehabilitation device that physically enabled clients can still leave them feeling disempowered. These observations and questions about the design of rehabilitation products was my inspiration to pursue a Masters of Applied Arts in Design and the impetus for this study on designing for empowerment. As a physiotherapist I understand how rehabilitation devices should work, but as a designer I see what these devices can become and the potential benefits of rehabilitation products that empower their users.

## 1.2 Hypothesis

I hypothesize that objects possess attributes that can provide users with a sense of empowerment and that these empowering qualities can be identified and applied to the design of body-worn rehabilitation devices.

## 1.3 Research Questions

1. How do users understand the term *empowerment*?
2. What objects do users find empowering?
3. What are the key empowering design qualities that can be applied in the design of body-worn rehabilitation products?
4. How can a rehabilitation device be designed to embody empowerment?

## 1.4 Overview

This thesis study is an investigation into how objects and experiences empower users and whether or not specific empowering qualities can be identified and applied to wearable rehabilitation devices. The design of Shoulderwear, a fashionable shoulder support for women, is a case study that applies the research findings of this thesis study to a wearable shoulder support for women.

This paper examined the empowerment of clients in the practice of physiotherapy to provide a better understanding of its role in the rehabilitation process. The system around the development and distribution of body-worn rehabilitation products was also analyzed to identify where the empowerment gaps occur between rehabilitation products and clients.

Design research for this thesis study included a literature review, precedent research and a research probe. From the literature review, articles by Bruno Latour and Abraham Maslow were most relevant to this thesis study. Patrick Jordan's book, *Designing Pleasurable Objects,* takes a holistic approach to pleasure-based design and serves as a model for empowerment for design and the inclusion of pleasure into rehabilitation devices. Several assistive medical devices were studied to compare and contrast design attributes that promote or impede user empowerment. The precedent research also examined the role of fashion in empowering wearers and how fashion may be applied to the design of body-worn rehabilitation devices. A literature review on research probes was performed to determine the methods and activities commonly used and the type of information that form of research can yield.

A research probe was developed for this thesis study to gain insight into how objects generate the feeling of empowerment within their users. For the purposes of this thesis study the probe focused on women and the research findings were applied in the design of Shoulderwear for women. Shoulderwear is a case study that uses the design of a women's shoulder support as an example of how body-worn rehabilitation devices can incorporate

the research probe findings on objects and empowerment. Analysis of the research probe results identified trends of objects that promote empowerment. Attributes related to empowerment are summarized to offer insights for designing rehabilitation devices that empower wearers and are synthesized in the case study. Several prototypes were created to transition the typical shoulder supports into Shoulderwear. Biomimetic research was also performed to develop a more effective system of stabilizing the shoulder joint.

## 1.5 Introduction

*Empowerment in Physiotherapy*

Empowerment in the health professions is the incorporation of an ideology concerned with choice and responsibility, skill development, and clients' quality of life (Aujoulat, d'Hoore, and Deccache 5). Physiotherapy is a health profession that provides treatment for any disease, injury, or deformity by physical methods such as exercise, heat treatment, and massage rather than by drugs or surgery (Oxford Dictionaries Online). In physiotherapy, client empowerment is a key component to a holistic treatment approach that includes addressing the physical rehabilitation and being a part of their supporting system. Acquiring a physical disability impacts the lives of pople beyond the anatomical structures of the body. For example, injuries from a motor vehicle accident may leave a client unable to work or perform normal daily activities. A sense of powerlessness may result when they now have to rely on others to perform basic tasks such as getting dressed and other activities of daily living. Being unable to work can also lead to a shift in identity from being *able-bodied* and productive to being *disabled* and unproductive. The professional practice of physiotherapy empowers clients by respecting them, maintaining their dignity, providing them with authority over their treatments, and equipping them with tools to recover independently. The empowerment of clients may help them overcome feelings of helplessness and prevent self-limiting behaviors that often delay the rehabilitation process.

The professional practice of physiotherapy has been developed to maintain client empowerment throughout the rehabilitation process as a method to minimize the power differential between clients and the therapist (College of Physical Therapists of Ontario 2). Client empowerment in the rehabilitation process also aids in the development of a good rapport by establishing mutual respect, maintaining client dignity and allowing the client to remain autonomous. In fact, the term *client* is preferred over the term *patient* because being a *patient* implies that the recovery process occurs passively whereas a *client* is actively participating in the rehabilitation process.

Another example of empowerment in physiotherapy is the procedure of *informed consent.* This process presents all the appropriate treatment options to the client (including the risks and benefits) to them with the knowledge needed to make an informed decision on a treatment best suited for them. For example, a client may choose ice as the best treatment option despite learning electrical nerve stimulation treatment may reduce pain more effectively. Giving clients the authority to decide which treatment will be applied on them is empowerment through *informed consent*. Client authority is also evident in several other areas of physiotherapy such as the right to withdraw consent to treatment at any time and whether or not clients will comply with their physiotherapists' recommendations.

Educating clients about their medical condition, or injury, and prognosis is also used by physiotherapists to empower clients (Pellino et al. 48 and Johansson et al. 84). In my clinical experience, educating clients about their injury and prognosis is empowering because they possess knowledge related to the mechanism of injury (what's wrong) and the stages of their recovery (how it will get better).

Physical empowerment of clients also occurs with the prescription of rehabilitation exercises and pain management strategies. Providing clients with pain management tools allows them to regain control over their pain symptoms rather than relying on health care professionals to reduce their pain (Green et al. 306). Regaining independence in the control of pain symptoms helps to counteract feelings of helplessness. The prescription of rehabilitation exercises empower because the rehabilitation outcomes become highly

dependent on clients' active participation to recover successfully. As with the right to withdraw consent, clients maintain their authority by having the choice as to whether or not to perform their exercises. The range of avenues that physiotherapists use to engender empowerment attests to the commitment the profession has to maintaining the dignity and autonomy of clients.

Although there is much attention placed on maintaining a client's empowerment in the clinical setting, there is little consideration for client empowerment in the current system of rehabilitation product development and prescription. This thesis study uses the Oxford Dictionaries Online definition of an *assistive device* to also describe *rehabilitation products and devices*. These items can be "any device designed or adapted to help people with physical disorders to perform actions, tasks, and activities" (Oxford Dictionaries Online).

*Empowerment Gap in the Development of Rehabilitation Products*

Diane Lee P.T., the creator of The COM-PRESSOR pelvic stability belt, reported that her goal for the COM-PRESSOR belt was solely to meet the specific functional goal of providing additional stability to the pelvis. She reported that client involvement only occurred during *Clinical Testing* to validate the device's effectiveness. The end result was the development of a highly functional device that is frequently prescribed by physiotherapists. However, this traditional approach to the development of rehabilitation devices overlooks the opportunity to design a positive user experience that can facilitate a better connection between the rehabilitation device and the user. Through a positive user experience and making a personal connection with a rehabilitation device there is a possibility for a device to empower its user as found in Section 1.1. In my clinical experience, clients often reported their displeasure with one or more design features of rehabilitation devices that deterred them from using the device as prescribed by their therapist or doctor. Common design problems reported by clients include the following: overheating, uncomfortable materials, difficult to put on, insufficient support, or visually unappealing. Involving clients during the development of the rehabilitation devices helps

identify elements related to negative user experiences that may lead to non-compliance and delay the rehabilitation process.

*Empowerment Gap in the Prescription of Rehabilitation Products*

In physiotherapy there are three stages for the purchase of a rehabilitation product: a prescription for a specific item is written by the therapist or doctor; the prescribed item is purchased; there is partial or complete reimbursement from a third party payer (various medical insurers). It is ironic that clients are not included in the decision-making process for a device that they may wear for several hours at a time, for several weeks, or even years. This exclusion of clients throughout the process also contradicts the empowerment model found in the clinical practice of physiotherapy.

As a physiotherapist, I have written prescriptions for clients identifying the purchase of specific rehabilitation devices, such as the COM-PRESSOR belt, because of unique functional features. I have also contacted third party payers, such as Met Life and Green Shield medical insurers, to verify that a client will be reimbursed for the purchase of the device. When the prescription is taken to a medical supply store, the sales representative will not usually suggest any alternative items if a specific brand and model have been specified. Clients will purchase the specified device and submit the receipt to the health insurer for their reimbursement. Once the client has acquired the device, the physiotherapist prescribes the frequency and duration of use. I believe the empowerment of clients can be restored through design attributes that create a positive user experience, provides the opportunity to personalize the device, or offers more options for clients to choose from.

This thesis study does not attempt to suggest any changes to the current system around the development or prescription of rehabilitation devices but it considers the design of rehabilitation products, with empowering attributes, to offset the disempowerment of clients from this process. I postulate that empowerment through the design of rehabilitation devices will complement the methods employed by physiotherapists and continually promote a sense of empowerment beyond the clinical setting.

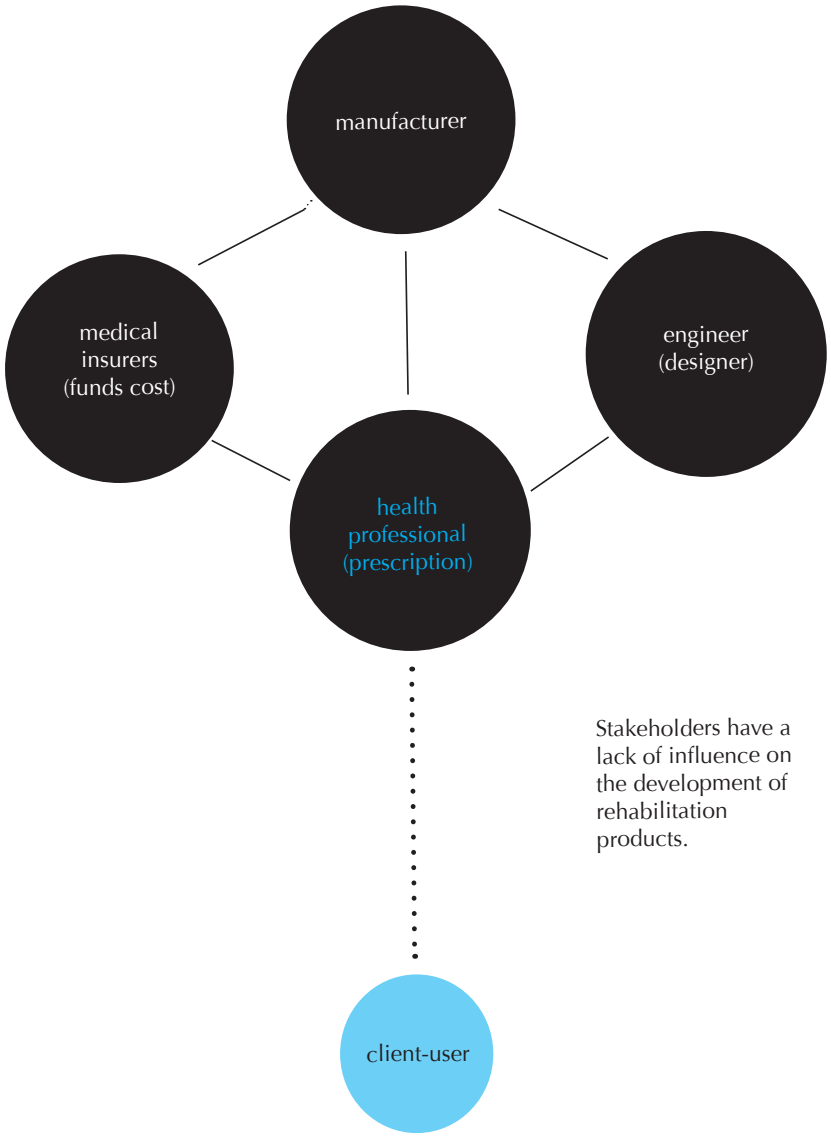


Figure 1. Rehabilitation Product Development and Stakeholders. This graphic is based on my experiences as a physiotherapist and illustrates the gap between clients and the other stakeholders in the development and distribution of rehabilitation devices. Image by Laurence Wong.

## 2.0 THEORY

## 2.1 Rehabilitation Products and Design

In general, it can be said that the use of a well designed object can bring joy to one's life, whereas poorly designed objects can be frustrating or cause an unpleasant user experience. In the context of an individual with a short-term or long-term disability the differences between these user experiences are magnified with potentially greater impact on the quality of life for clients.

*The Actor Network Theory*

The significant role that design plays in the lives of individuals with physical disabilities is apparent when Bruno Latour's *Actor Network Theory* (151) is considered with respect to rehabilitation devices. For example, clients with nerve injuries to the neck and arm from a motor vehicle accident may be prescribed the use of a shoulder support. According to Latour, the shoulder support plays a significant role in how clients will behave because it becomes a key prop or an "agent" that clients will have to negotiate or interact with, and the device will ultimately impact their behavior in some way. Without the shoulder support, clients may be hesitant to participate in daily activities or socialize with others due to pain, a loss of function, or being self-conscious of their disability. Despite physically receiving adequate stability from a shoulder support, clients may continue to feel disabled or be over-protective of their arm because of the signals projected by the device's visual design language or materiality. Materials such as thick neoprene or wide elastic bandaging may feel restrictive and confining, so clients may feel compelled not to use the arm, thus placing them at risk for the development of subsequent problems later on. Also, as a 'prop', there is a strong likelihood that a shoulder support's visual design language may also influence clients' confidence while wearing the device. This, of course, depends on the qualities of the design. Many factors may reduce confidence, from the sensation that it isn't supportive to an appearance that suggests disability to the wearer and to the public.

The Actor Network Theory can also be applied to demonstrate how clients may behave and feel differently with the use of an empowering rehabilitation device. If clients wore a shoulder support with empowering design qualities they may feel more confident with the use of their shoulder and they may feel less disabled since they are not constantly being reminded of their injury. An empowering shoulder support may attract positive attention from others, in the form of compliments, thereby promoting self-confidence. From my professional experience as a physiotherapist this shift of perception can help to reduce self-limiting behaviors that can prolong the rehabilitation process.

## 2.2 From Designing Pleasurable Products to Empowering Rehabilitation Devices

In Patrick Jordan's book, *Designing Pleasurable Objects*, he challenges the traditional utility-based approach of human factors design and looks to a pleasure-based approach to design (11). He states that the pleasure-based approach to design sees users in a holistic manner rather than being focused on the object and its function (11). To establish the value of pleasure in relation to function Jordan refers to Abraham Maslow's *Hierarchy of Needs* theory in creating a similar theory, the *Hierarchy of Consumer Needs* theory. Abraham Maslow's *Hierarchy of Needs* theory (372) is a theory that describes how human behavior is motivated by the desire to fulfill the most fundamental needs before progressing to the fulfillment of higher levels of need (see fig. 2.).

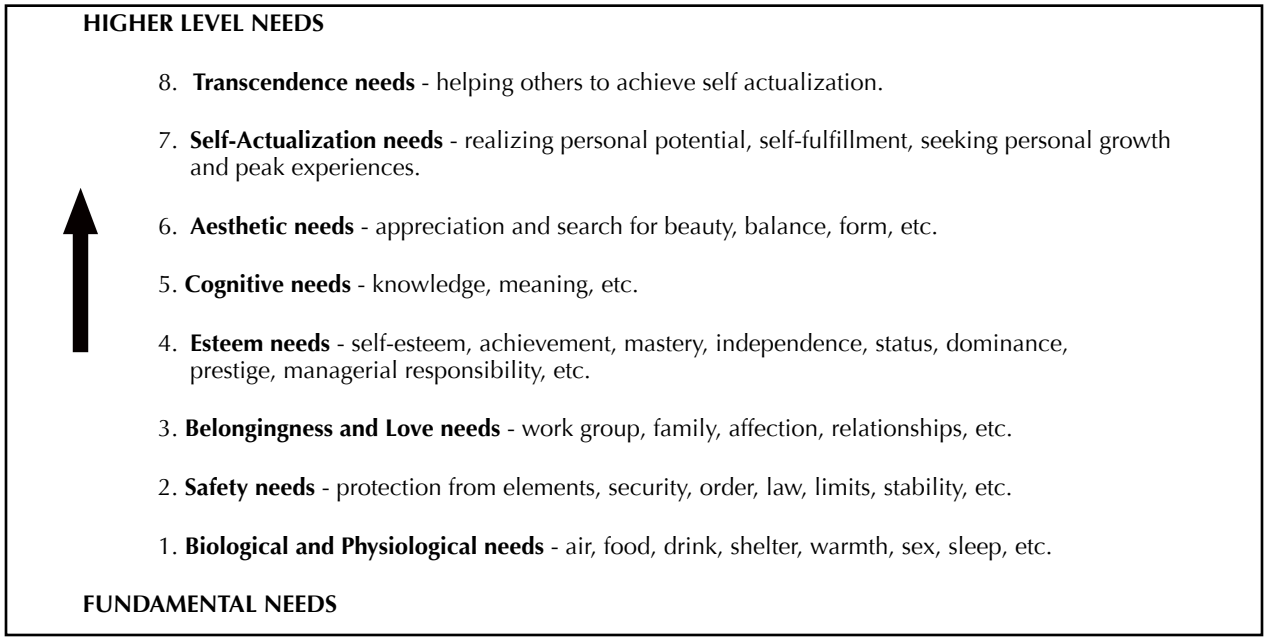

Figure 2. Abraham Maslow's *Hierarchy of Needs Theory.* Image by Laurence Wong.

In the *Hierarchy of Consumer Needs* consumers look to meet their basic consumer needs before looking to fulfill the higher levels of need (4). In his theory, Jordan identifies three levels of consumer needs (see fig. 3.): *Functionality* (the most basic level); *Usability* (the intermediate level); and *Pleasure* (the highest level of consumer need).

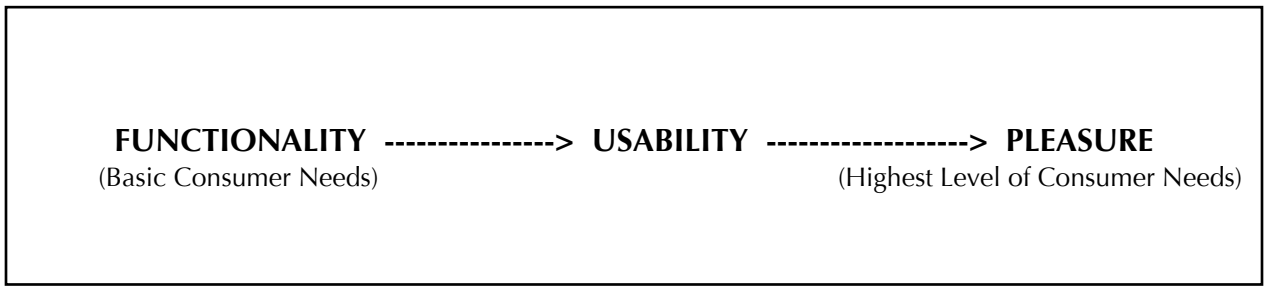

Figure 3. Patrick Jordan's *Hierarchy of Consumer Needs* theory. Image by Laurence Wong.

With pleasure being the highest level of consumer need in the *Hierarchy of Consumer Needs* Jordan examines *pleasure* more closely and identifies the following four types of pleasure: physio-pleasure, socio-pleasure, psycho-pleasure and ideo-pleasure (13).

The list below defines each type of pleasure:

*Types of Pleasure*

- Physio-pleasure: "pleasure derived from sensory organs"
- Socio-pleasure: "enjoyment derived from the relationship with others"
- Psycho-pleasure: "cognitive and emotional pleasure"
- Ideo-pleasure: "pleasure related to personal values" (Jordan 13).

Jordan relates pleasure to enjoyment, gratification and desire, and pleasurable with pleasurable products providing additional emotional and practical benefits (12). In contrast, empowerment is associated with making someone stronger and more confident (Oxford Dictionaries Online) and, in the health professions, the ideology concerned with choice and responsibility, skill development, and clients' quality of life (Aujoulat, d'Hoore, and Deccache 5). Although the purpose and end goal for empowerment through design is very different from the design of pleasurable products, Jordan's holistic approach provides a framework for empowerment in design throughout this thesis study.

*Empowerment and Pleasure*

From Jordan's holistic approach to pleasure, this thesis study also identifies four types of empowerment:

- *Physical Empowerment*: empowerment through physical enablement or that provides an empowering experience through the senses.
- *Social Empowerment*: gaining confidence through positive social interaction.
- Psychological Empowerment: gaining a self-confidence through any means available (may be experience-generated, object-generated or self-generated)
- Ideological Empowerment: empowerment through means of self-expression of personal ideals, beliefs, attitudes

This research study explores objects that reportedly empower the user, in order to identify their design qualities and to determine if the resulting experiences fall within the four types of empowerment listed above. I refer to the pleasure-based approach to design as a model in designing to address each type of empowerment. I also acknowledge pleasure as

an empowering attribute; however, I do not assume that a pleasure-based design approach will yield rehabilitation devices that will empower their users, since not enough is known yet about user empowerment through objects and design. As a Master's Thesis, the research performed on user empowerment through objects only begins to address the knowledge gap on the relationship between empowerment and design, as the concept of empowerment in the health professions has yet to be well defined (Aujoulat, d'Hoore, and Deccache 1). The research finding from this thesis study begins to provide an insight into how people experience empowerment through objects.

*Empowerment and the Hierarchy of Needs*

Although Jordan describes designing for the four different types of pleasure in great detail he does not attempt to make any further connections to Maslow's *Hierarchy of Needs* once pleasure has been achieved. On the other hand, in this thesis study Maslow's theory can be viewed an evaluation tool to measure the success of a rehabilitation product's design rather than as motivation for behavior. Although it is beyond the scope of this thesis study, I hypothesize that rehabilitation products designed with attributes to facilitate empowerment can help individuals with disabilities fulfill multiple levels of needs. For example, a well designed shoulder support from the scenario described in Section 2.1 will fulfill: the basic *physiological needs* by providing stability to the shoulder joint; *safety needs* by enabling the user to hold onto a handrail and avoiding a fall on slippery floors; *esteem and aesthetic needs* through a visual appearance or design language that does not reinforce the traditional stigma associated with being physically disabled. According to the Hierarchy of Needs Theory, higher level needs of self actualization and transcendence may be pursued once lower level needs have been fulfilled (Maslow 372).

## 2.3 Precedent Research

> *"Fashion is largely concerned with creating and projecting an image: making the wearer look good to others and feel better about themselves. The priority for design for disability has traditionally been to enable, while attracting as little attention as possible. And the approach has been less about projecting a positive image than about trying not to project any image at all."*
>
> (Pullin 15)

Several rehabilitation products illustrate the relationship between fashion, visibility and empowerment. I examined conventional shoulder supports to identify common design features for body-worn rehabilitation devices that are routinely prescribed by physiotherapists. Many of these features address the biomechanical needs related to joint injuries. However, they also demonstrate how the current design of many rehabilitation devices may leave users feeling disempowered. On the other hand, prosthetic covers or "*Fairings*" by Bespoke Innovations Inc., and a plethora of eyeglasses have transcended the basic functional requirements of a medical device by providing the opportunity for individuals with disabilities to express themselves through their rehabilitation products. In particular, eyeglasses have been embraced by their users and by others thanks to how the visual design language has elevated the devices beyond the stigma commonly associated with impaired vision (Pullin 17).

*Shoulder Supports in the Marketplace*

A survey of shoulder supports currently found in the marketplace shows there are common design features with other body-worn rehabilitation products such as supports for the wrists, elbows, knees and ankles. The product survey covered websites of medical and rehabilitation suppliers (such as OrthoCanada) and shoulder support manufacturers, since medical supply stores in the Vancouver area (such as The SportMed Shop, MacDonald Prescriptions and Medical Supplies, Lancaster Medical Supplies and Regency Medical Supplies) carry a limited selection of shoulder supports. These retailers generally order a

specific shoulder support from their distributor when it has been prescribed by a health care professional. I analyzed the most common shoulder supports to evaluate their effectiveness in stabilizing the shoulder joint, the materials used, the ease of application, and the visual design language. An empathy exercise was used to anticipate user experience from several perspectives including the visual design language, the feel and properties of materials, and the complexity of use.

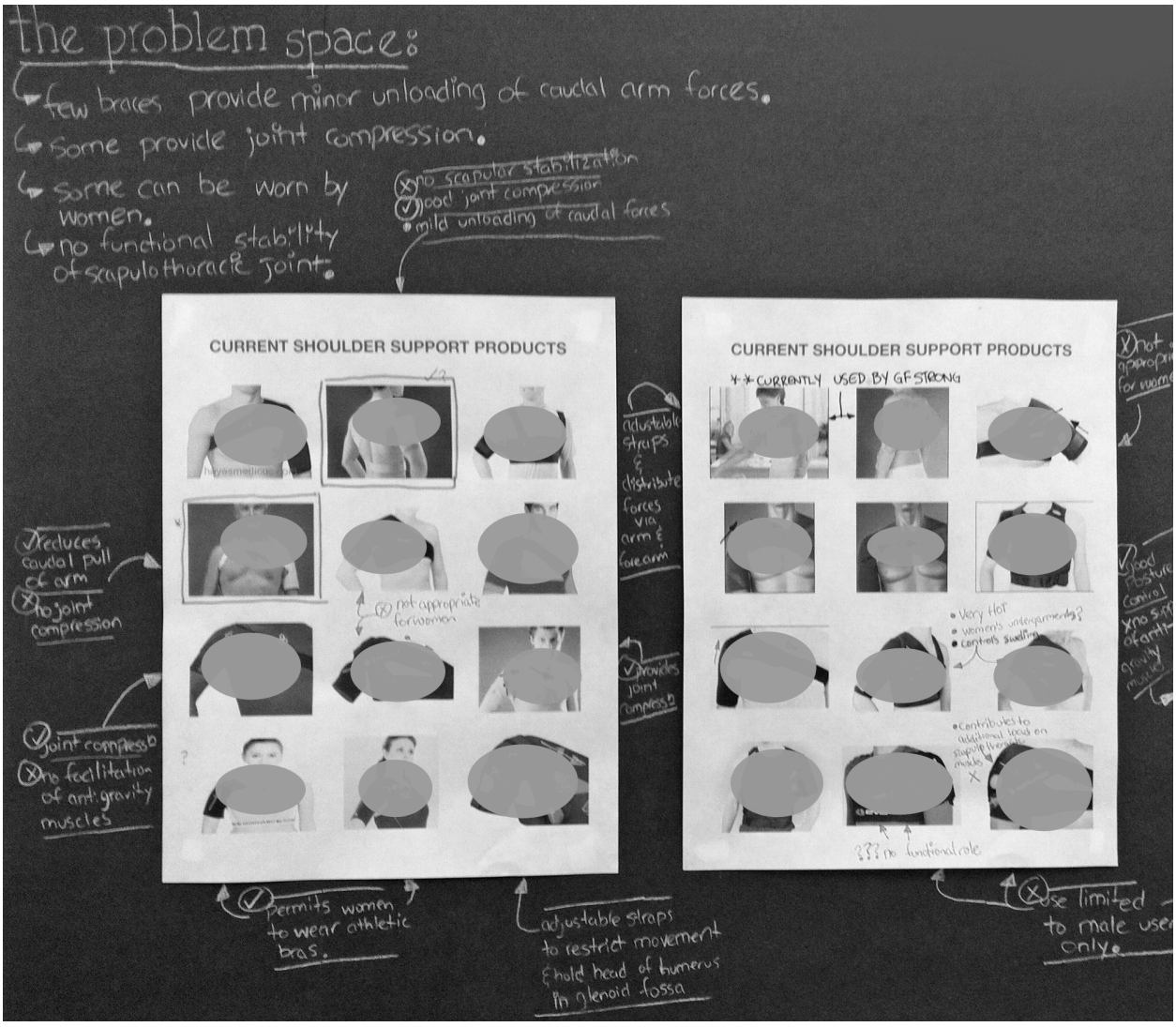


Figure 4. Research Precedent: a systematic analysis of shoulder supports currently available in the marketplace. Photo by Laurence Wong (images of the shoulder supports reviewed are obscured due to copyright restrictions).

An analysis of conventional shoulder supports was performed to evaluate the following design properties:

**material**

- breathability
- comfort
- weight

**effectiveness**

- ease of application and removal
- shoulder joint compression
- shoulder joint stabilization during movement
- unloading of the shoulder ligaments
- feasibility for women (i.e. accommodating a bra and breast tissue)

**design**

- user experience (enjoyment, pleasure, empowerment)
- semiotics, social messages being conveyed, reinforcement of the shoulder disability, overcompensation, learned helplessness
- self-perception, self-esteem, shame
- social-perceptions, stigma
- colour options

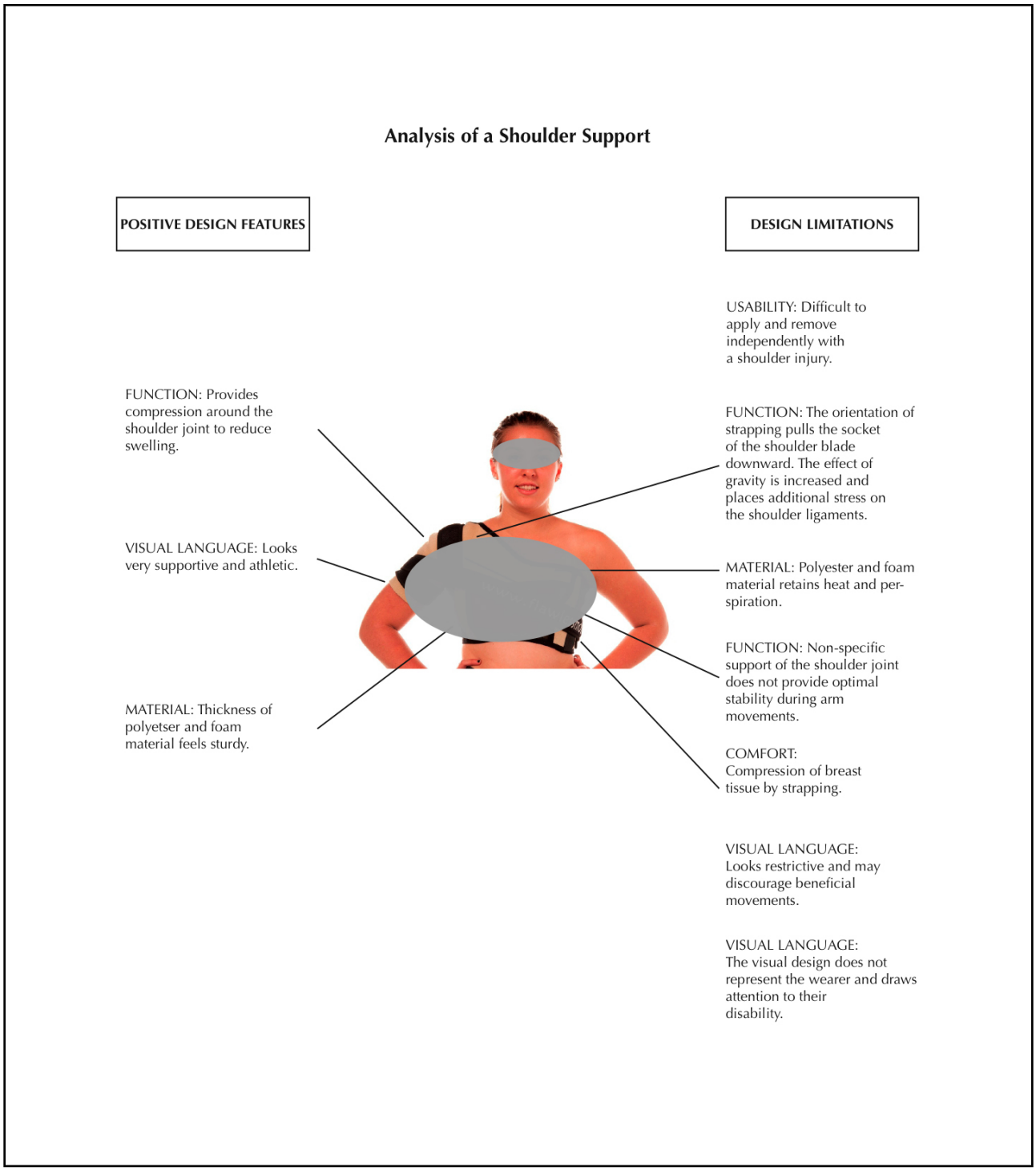


Figure 5. Precedent Research: a detailed analysis of a conventional shoulder support (portions of the above image have been obscured due to copyright restrictions).

The key findings from the market research analysis revealed the most common material used in shoulder supports is neoprene followed by polyester (with tensor support bands). The functional limitations of neoprene are that is thick, heavy and non-breathable. The material properties of shoulder supports constructed of polyester (with tensor support bands) offers a lighter and slightly more breathable device.

The vast majority of current shoulder supports provide compression around the shoulder joint and are held in place by a strap across the chest. However, the orientation of the strap does not replicate natural muscle forces that assist with the unloading of shoulder ligaments.  In fact, the orientation of the securing strap across the chest causes the socket of the shoulder blade to angle downward, instead of upwards, where gravity has a greater effect in pulling the ball away from the socket. The OmoTrain Shoulder Support and the Hemi Arm Sling are currently the only shoulder supports that appear to unload the weight of the upper arm without pulling the socket into a downward angle.

The neoprene shoulder supports resemble athletic equipment used for sports such as football or hockey and colour options are very limited. The most common colour for shoulder supports currently in the marketplace is black with white, blue and tan colours also available to as lesser degree. Other shoulder supports made with polyester and wide elastic support bands have an appearance that resembles thick medical bandages. The design aesthetics may cause clients to focus on their disability that may lead to being overprotective of their injury or non-compliance with the prescribed use of the device. For some wearers, a body-worn rehabilitation device, that is visible to the public, may draw unwanted attention to the disability or cause embarrassment. In other words, some users may feel less confident or disempowered, due to the visual language of a rehabilitation device, despite physically having reasonable shoulder support.

*Fairings*

Fairings are custom panels that cover the mechanical components of a prosthetic leg (see fig. 6.). Bespoke Fairings have received several awards for their product despite making no contribution to the overall function or performance of the prosthetic limb. The recognition for the award winning design is based on creating a new social perception for prosthetic limbs. In being an Industrial Design Society of America, IDSA, Gold Award Winner in 2011 the association noted, "Bespoke Fairings communicate the users' sense of style and taste, allowing them to connect with the artificial limb in a personal and emotional way" (IDSA Website). Instead of trying to hide the loss of a limb, the fairings invite public attention through the form language and the use of high quality materials such as chrome, wood or carbon fiber. This product provides an excellent example of the contrast between the traditional approach to rehabilitation product design as described above and empowering wearers through design. Traditionally, prosthetic coverings would have been flesh-coloured foam and rubber in an attempt to disguise disability by mimicking a limb. According to Pullin this was usually unsuccessful and may have even drawn more attention to the wearers' disability (15). Davin Stowell of the IDSA states, "this is pure fashion that goes well beyond vanity to be the noblest self-expression for the amputee, evoking only admiration—no pity" (IDSA Website).

Figure 6. Research Precedent: Bespoke Innovations Inc. Fairings for a lower leg prosthesis. The original photo by Bespoke Innovations Inc. has been substituted due to copyright restrictions.

According to Bespoke Innovations' official website their goal is to create a positive experience through their fairings.

> "Fairings express confidence, creativity and individuality. Fairings help erase the wall of awkwardness that can disconnect the amputee from the world around. Fairings invite interest, but for all the right reasons. An uncomfortable glance is now an admiring gaze. Our hope is to enable our clients to emotionally connect with their prosthetic limbs, and wear them confidently as a form of personal expression. By creating a unique custom form that presents the individual, Bespoke Innovations hopes to change the way the world thinks of prostheses."
>
> (Bespoke Innovations Inc. Website)

The website also provides quotes from clients such as Chad who reports that his positive experiences include having a conversation piece, providing a perfect fit with his boots and having them replace the need to wear shin guards when he plays soccer (Bespoke Innovations Inc. Website). Another Bespoke client, Deborah, owns several Fairings and makes a selection based on her mood or to complement her attire. "Her Fairings include a set in black lace and chrome, another that suggests fishnet stockings, one appearing as white lace, and still another wrapped with tattooed leather. She now wears skirts at every opportunity to show the world her custom legs" (Bespoke Innovations Inc. Website).

> "People finally got it," she said. "Instead of trying to blend in and be like everyone else, now I really go out of my way to show off my leg. I'm coming back more to myself and being creative with my outfits. I try to match the leg to my outfit. With the chrome leg you can do a lot of cool 80's things like matching it to leather jackets with grommets and leather boots with accents. It's taken me all of this time to get my confidence back and to be a whole person again.

> Not only do the Fairings embody her sense of fashion and taste, they also return to her body a sense of symmetry. Pants hang normally around her new calf, and boots surround calves with the same contours.
>
> "I needed to have shape with my leg, it was very important to me," she said. "I really like my Fairings. I'm glad Bespoke cares so much about us and how we look."
>
> (Bespoke Innovations Inc. Website)

The lesson provided by Bespoke Innovations Inc. is that there is more to the design of a medical device than meeting functional goals. The comments by Fairing wearers describe positive experiences physically, socially, psychologically and ideologically. The types of positive experiences reported by the wearers support the holistic approach in designing rehabilitation products that empower users as described in Section 2.2.

*Eyeglasses*

Eyewear provides a prime example of the overlap between fashion and disability. While for most of the past century there was a great deal of social stigma attached to wearing eyeglasses, this is no longer the case. According to Pullin "the positive image for disability has been achieved without *invisibility"* (Pullin 15). Further, he reports that up to 20% of some brands of glasses are purchased with clear non-prescription lenses for people without a disability. In other words, "for these consumers wearing glasses has become an aspiration rather than a humiliation" (Pullin 17). During the 1960's and 1970's, pink plastic framed glasses were prescribed as an attempt to be invisible but instead, this suggested "a lack of self confidence that can communicate an implied shame ... even though corrective laser surgery and contact lenses are now readily available eyeglasses continue to co-exist despite not being invisible" (Pullin 17).

Figure 7. Precedent Research: fashionable eyewear (the original image has been altered due to copyright restrictions).

Pullin outlined seven lessons learned from the transformation of eyeglasses to eyewear that have been adapted to the design of body-worn rehabilitation devices:

**Lesson #1: When referring to glasses, "what others see is more important than what you see yourself"** (Pullin 18).

> When others take notice of a body-worn rehabilitation device the wearer may experience positive or negative reactions. In the case of a positive reaction the wearer may receive a compliment of notice or a look of admiration. On the other hand, a negative reaction may be uncomfortable questions about the wearer's disability or others avoiding social interaction with the wearer.

**Lesson #2: Glasses are <u>worn</u> rather than used. Therefore, the terms <u>eyewear</u> and <u>wearer</u> are more appropriate than <u>user</u> and <u>medical appliance</u> (such that glasses are designed for the wearer rather than for its primary use of vision correction)** (Pullin 18).

> If the same notions of a *wearer* and *eyewear* are applied to the case study for this thesis, the re-design of a women's shoulder support, it would be redefined as *shoulderwear* and would be as much a fashionable accessory as it is a rehabilitation device.

**Lesson #3: The frame's function is to hold the lenses but equally important, they are a frame for the eyes, their expressions and the face. Glasses are designed in relation to the most personal part of the body - not in isolation** (Pullin 18).

The key element of this lesson is that a body-worn rehabilitation device, similar to glasses, should not be designed in isolation. For example, the design of a wrist splint, shoulder support or knee brace should complement clothing items (including undergarments) fashionably and functionally.

**Lesson #4: Because glasses are worn over the most personal part of the body there is a need for variety and choice. A single design may not suit everyone** (Pullin 18).

Rehabilitation devices should consider offering a variety of choices, options to personalize devices, custom ordering or offer designs that represent different lifestyles.

**Lesson #5: Many fashion labels design and market eyewear alongside spectacle manufacturers. The term eyewear positions glasses more as an item of clothing than as a medical appliance** (Pullin 19).

Body-worn rehabilitation devices can be a fashionable accessory because fashion's priority is to make the wearer look good to others and feel better about themselves (Pullin 15).

**Lesson #6: Glasses play off clothing, accessories, cosmetics and hairstyles in addition to bone structure. Fashion and trends become relevant for the design of glasses** (Pullin 19).

The re-design of any body-worn rehabilitation device should note that it will not be worn in isolation but rather in conjunction with many other forms of fashion. For example, the case study for this thesis, *Shoulderwear,* takes into account that the shoulder support will be worn with women's undergarments and a variety of clothing items based on the wearer's lifestyle.

**Lesson #7: Wearers look forward to purchasing a new pair of glasses like they do with the purchase of a new outfit, wardrobe or before trying a new hairstyle. New glasses are an opportunity for the wearer to try something different and reinvent themselves a little** (Pullin 17).

> Body-worn rehabilitation products should generate a similar sense of anticipation for clients during the purchase of the device and when there is an opportunity to wear it.

The evolution of eyeglasses perhaps best exemplifies the value of fashion in design for disability. The successful transition of eyeglasses into fashionable eyewear illustrates how body-worn medical devices can help make the wearer look good to others and feel better about themselves. Increasing self-confidence privately or through positive attention by others in public is one component of empowerment as defined as *"giving (someone) the authority or power to do something: make (someone) stronger and more confident"* (Oxford Dictionaries Online).

Perhaps more importantly, as a physiotherapist, a fashionable rehabilitation device potentially empowers a client whenever it is worn. Since these devices may be worn for several hours each day the sense of empowerment they provide can extend beyond the empowerment gained through physiotherapy.

In summary, the three precedents discussed in this section (conventional shoulder supports, Fairings by Bespoke Innovation Inc., and eyeglasses) lay a foundation for understanding design attributes that promote or diminish the sense of empowerment for clients. I contend that the visual design language (the medical and athletic appearance), material selection (thick neoprene) and difficult usability of common shoulder supports do not contribute to the empowerment of clients. On the other hand, the design language and materials used with eyeglasses and prosthetic leg fairings promotes acceptance, enjoyment, and empowerment. The relationship between empowerment and fashionable eyewear is noteworthy since the definition of empowerment includes providing someone

with confidence, and according to Pullin, “the aim of fashion is making the wearer look good to others and feel better about themselves” (15).

## 2.4 Research Probes

To gain insight on how to gather data on the term empowerment as perceived by product users, I developed a research probe that was modeled on elements of research toolkits by Elizabeth Sanders, a pioneer and authority on co-creation activities and design research (19), and design probes by Bill Gaver, a pioneer and authority on research probes (Cultural Probes 22). According to Sanders a probe is primarily a method of generating design inspiration by sending ambiguous stimuli to people and gaining insight from material returned (20). More recently, probes have been used to better understand the experience of others (Sanders 20). A research probe as defined by Bill Gaver is, “collections of evocative tasks meant to elicit inspirational responses from people—not comprehensive information about them, but fragmentary clues about their lives and thoughts” (Cultural Probes and the Value of Uncertainty 53).

I chose a probe was chosen to research empowerment because it is an open-ended technique that places few constraints on the responses of participants. Although the dictionaries provide formal definitions for the term “empowerment”, I was interested in how the term is interpreted by product users. The research probe for this thesis study was designed to look for insights and trends related to empowering design attributes with the intention of applying these qualities to the design of body-worn rehabilitations devices.

# 3.0 METHODOLOGY

## 3.1 Researching Empowerment for Industrial Design

For the purposes of this thesis study the research probe focused on women and the research findings were applied in the design of Shoulderwear for women. Shoulderwear is a case study that uses the re-design of a women's shoulder support as an example of how body-worn rehabilitation devices can incorporate the research probe findings on the relationship between objects and empowerment.

The purpose of the probe was twofold:

1. to acquire validation that objects in daily life can in fact provide women with a sense of empowerment.
2. to develop further understanding of what empowerment meant to women on a practical level and on an individual basis.

*Developing the Research Probe*

I considered several research probe activities in the development of the Research Probe Kit. All potential probe activities focused on having each individual provide their understanding of empowerment and finding a method for them to represent their definition in a physical or visual manner. A pilot study was performed with graduate students to gather feedback on proposed research probe activities. The activities under consideration included placing pictures on a grid as an attempt to obtain a visual representation of images that represent empowerment and disempowerment.

Other prototype activities included placing words along a disempowerment-empowerment scale and photographing articles of clothing that participants reported as empowering. The word placement activity was an attempt to gain a better understanding of how empowerment was perceived on a personal level. The photography activity aimed to identify the empowering attributes related to fashion.

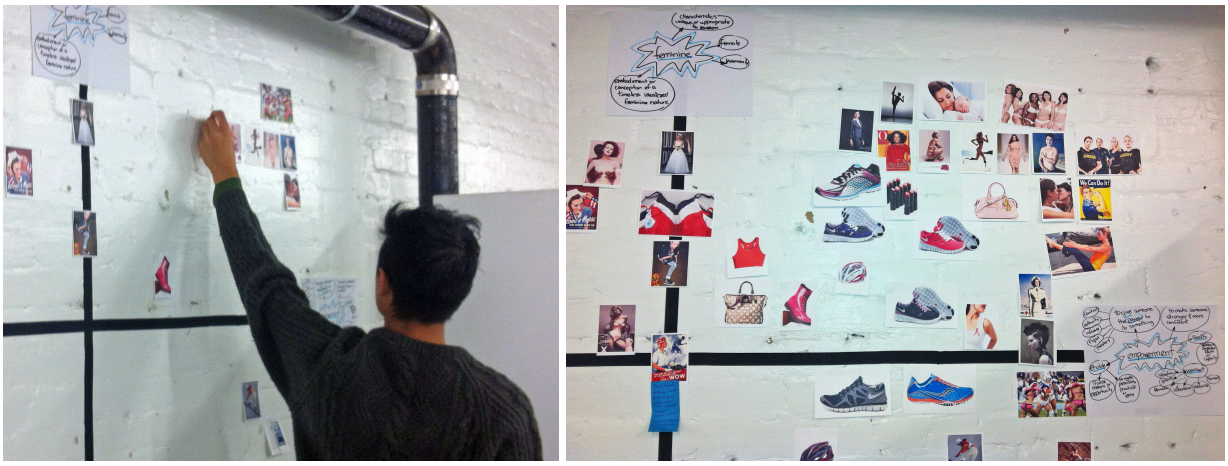

Figure 8. Research Probe Prototypes: a class exercise to test co-creation activities before being administered to research participants. Photos by Laurence Wong.

### 3.2 The Research Probe Kit

I created a research probe kit from the feedback and refinement of earlier prototypes tested with colleagues in the design studio. The research probe kit was distributed to seven women that accepted an invitation to participate in the study. They represented great diversity in the following categories: age, occupation, ethnicity, education level, family life, activity levels, past medical history and personal style.

*The Research Probe Participants*

*Age* - Three participants were between 20-29, two participants were between 40-49 and two participants were between 50-59.

*Occupation* - the participants represented a high degree of diversity in employment. Occupations included a manager, an accountant, two students, a server, a homemaker and a hair stylist.

*Education Level* - the research probe included university graduates of Bachelor and Masters Degrees as well as undergraduate students and graduates from vocational programs.

*Activity Levels* - all participants of the research probe were generally in good health and with height to weight ratios estimated to be within the normal range. However, there was great variability in the fitness and activity level of the participants that ranged from infrequent physical activity to routine exercise such as golfing, fitness classes, yoga or running.

*Personal Style* - research participants were also invited to participate based on the diversity of their personal style and attitude towards fashion. Some participants were business professionals, others worked with customers or were currently students. Their approach towards fashion varied from traditional to mainstream fashion trends, and was an expression of their individual sense of style. As discussed in the precedent research on eyewear in Section 2.3, any item placed on the body has the potential to be a fashionable item.

*Ethnicity* - participants were of Asian and European decent.

*Family Life* - The family life of the participants varied: some were single, some were married and some were parents.

*Past Medical History* - research probe participants reported having past or present musculoskeletal injuries to various regions of the body and requiring minor to significant physical rehabilitation. Conditions ranged from tendonitis, sprains and strains to fractures.

*Research Probe Kit Instructions*

From a list of 55 words related to empowerment, participants were asked to identify the 10 words they felt represented their own personal understanding of the term or to write their own definition if they chose to do so. The words were then numbered from 1-10. The next step required participants to find items that they owned or used on a regular basis to represent each of the words they chose. Participants then photographed the items with a disposable camera provided in the research kit. Each participant was asked to further describe how the items photographed provided them with a sense of empowerment. The final step was to place the camera and paperwork into a return envelope and to drop the package off at the nearest mailbox.

All aspects of the research probe were carefully considered in order to create a positive experience while participating in the research probe. The probe activities now required participants to only select 10 words that represent empowerment to them. Participants were then able to select any item they own, wear or use regularly that best represented the words they selected. The physical representation of empowerment was more descriptive since there were no restrictions placed on items selected. To further promote a positive experience, participants were encouraged to perform the research activity with a friend or a family member as a social activity and the kit included chocolate for consumption while performing the probe activities.

*Research Probe Kit Distribution*

In most cases, a meeting was scheduled to review the instructions for the research probe, to complete the consent and model release forms, and to deliver the contents of the kit. Participants were also reminded to write one sentence on the leaflet with the 10 selected words describing how each item they had photographed empowered them. The leaflet and the camera were to be returned together through the mail.


Figure 9. Contents of Research Probe Kits. Photos by Laurence Wong.

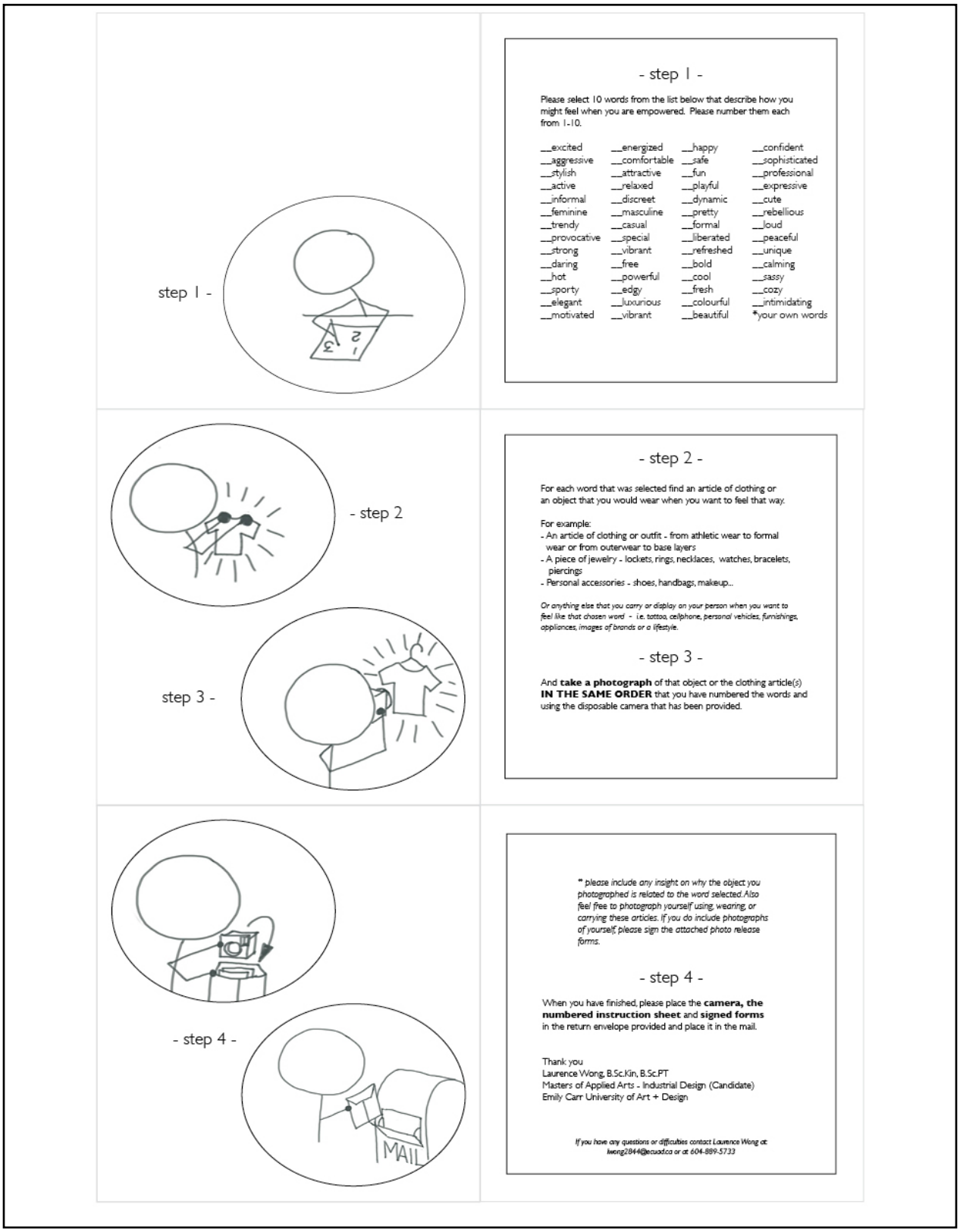


Figure 10. The Research Probe Instructions. Image by Laurence Wong.

## *3.3* Research Probe Results

Although the sample size of the research probe was limited to seven participants the findings begin to provide insights into how women perceive empowerment, what objects they find empowering, and the attributes of objects that empower them. The words chosen by the participants are shown below along with the frequency of selection.

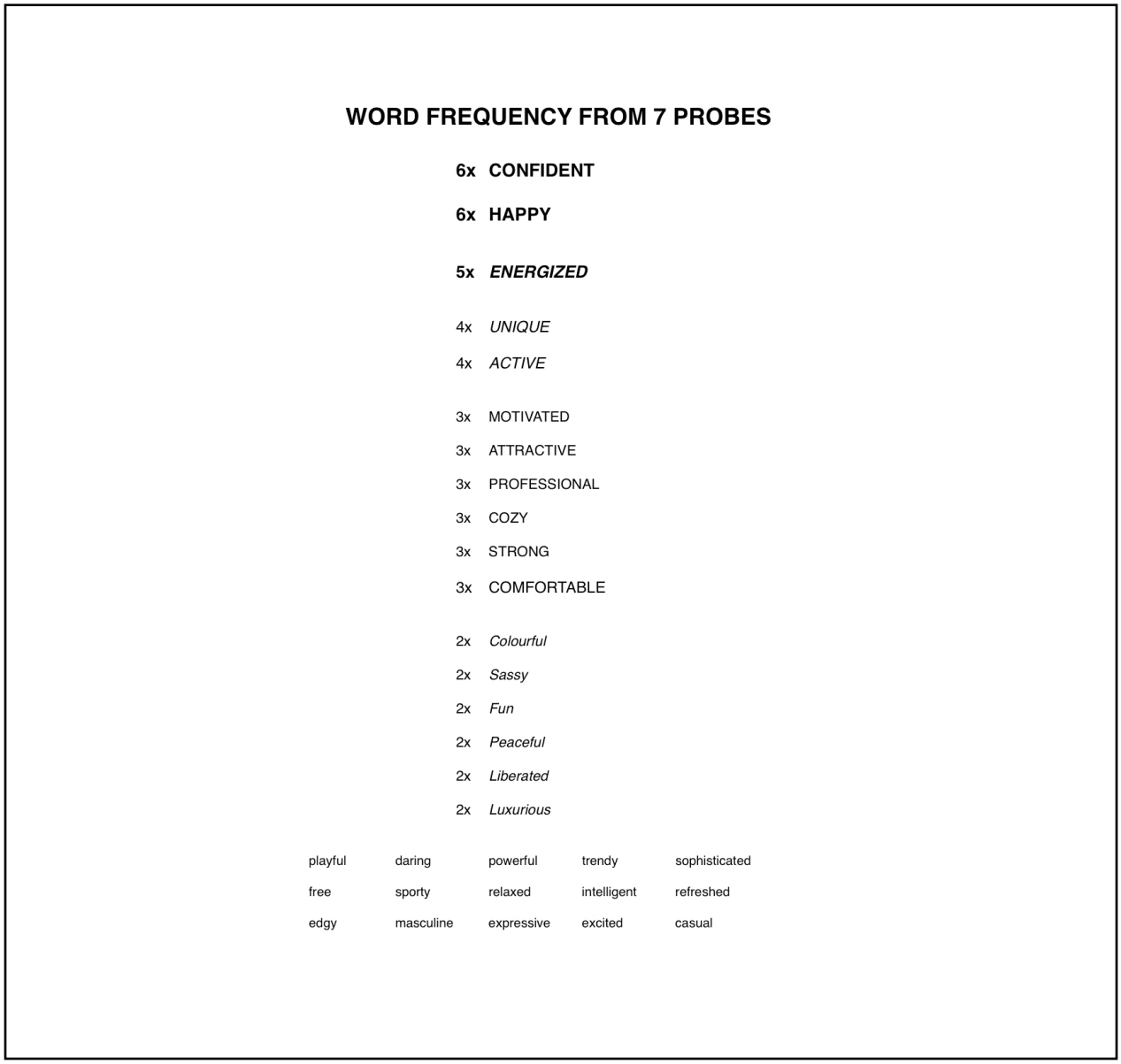


Figure 11. Research Probe Results: frequency of words selected by participants to represent empowerment. Image by Laurence Wong.

*Examples of Research Probe Responses*

(The names of participants have been changed for the purpose of maintaining anonymity)

"Diana" is an assistant manager, and several items she photographed were related to conveying a professional image to employees in her workplace (see fig 12.). She reported that such items made her feel more confident and she also stated they helped gain respect in the workplace (glasses, briefcase, high heels). She also included recreational items but reported that the sensation of being active through these items was more empowering than the visual appearance (hand weights, and running shoes).


Figure 12. Research Probe Results: "Diana" - research participant #4 (40-49yrs). Photos by Participant #4 and the summarization by Nicole Barrett.

The images and comments provided by "Zoe" also demonstrate the diversity of objects that can be empowering (see fig. 13.). She describes feeling empowered through self-expression with her eyelash necklace and tiger print dress. She reported being equally empowered by comfortable items, with slippers described as feeling indulgent but an oversized sweater described as being an anti-fashion statement. She also reported feeling empowered by clothing that projected a mature and professional image (blazer) and by items worn to generate a reaction from others in public.

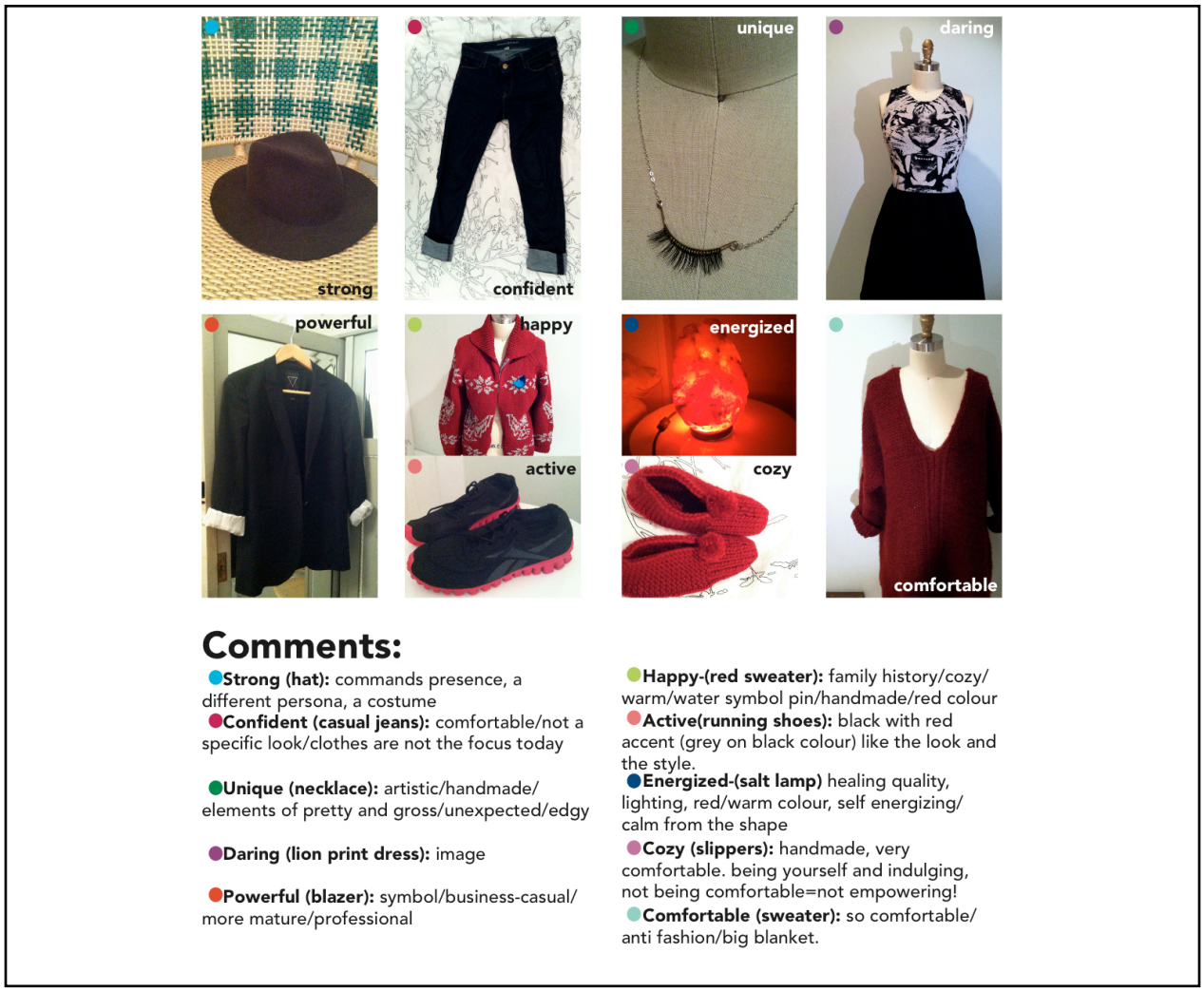


Figure 13. Research Probe Results: "Zoe" - research participant #6 (20-29yrs). Photos by Participant #6 and the summarization by Nicole Barrett.

*Methods of Analysis*

The results of the research probe were analyzed in several ways and included the following:

1. Word Frequency: The number of times a word was selected as a descriptor of empowerment.

2. The Type of Empowerment: Items seemed to fall into one or more of the four categories of empowerment as described by Jordan in Section 2.2:
   (i) social empowerment,
   (ii) physical empowerment,
   (iii) psychological empowerment
   (iv) ideological empowerment

3. Other Noteworthy Trends: General trends among the empowering items photographed.

*Trends*

Word Frequency: Words most commonly selected from the list supplied in the probe. Several trends were identified from the information collected through the research. Particular words representing empowerment resonated with the participants such as *happy* and *confident* (selected by 6 of the 7 participants) followed by *energized* (chosen by 5 of the 7 participants). A list was created with all the words selected by the participants, along with the frequency with which they were chosen, a deeper analysis was performed for each word through cross referencing with the corresponding item photographed and their comments on how the item was empowering. Trends observed from the research probe results are described in greater detail in the next sections.

Type of Empowerment: The comments provided by the research probe participants describe empowerment from object occurring in specific that include the following: attracting positive attention; feeling enabled; feeling secure or comfortable; promoting an

empowering experience; or an object is used as a form of self-expression. These empowering experiences are consistent with the four empowerment categories described in Section 2.2: (i) *social empowerment*, (ii) *physical empowerment*, (iii) *psychological empowerment* and (iv) *ideological empowerment*.

(i) *Social Empowerment: "*attracting attention"

The next step of analysis was to identify if the empowerment occurred privately or invited attention from others in publicly (social empowerment). A large portion of the items documented were reported to provide an additional sense of empowerment when others reacted to the object being used or worn (see fig. 14.). Examples of positive attention from others include respect, admiration, shock or general attention. Items providing social empowerment included clothing, makeup, tattoos, jewelry and other fashionable accessories. It was reported by one participant, Diana, that her high heeled shoes were empowering because of the compliments she received from men and women.


Figure 14. Research Probe Results: the comments accompanying these items indicated they were worn or used to encourage a positive reaction or attention from others (i.e. respect, admiration or shock). Photo by Laurence Wong.

(iia) *Physical Empowerment:* "feeling enabled"

Items fulfilling a functional role reportedly empowered participants by physically enabling them to perform tasks or activities; however, they also reported experiencing psychological empowerment from the same items and they stated *feeling* more professional, energized, motivated, or confident through the use functional items. For example, the participant, Jess, reported her dance shoes were empowering because they were motivating (*psychological empowerment*) and they functionally allow her to dance (*physical empowerment*). Physical empowerment also occurred through non-functional items and appears to be more related to sensory experiences such as wearing a comfortable sweater or cozy slippers.

(iib) *Physical Empowerment: "*sensory experience"

The sensory experience of empowerment was reported with items such as compression socks, warm beverages, hand weights, slippers and sweaters. Hand weights and compression socks provided users with the physical sensation of strength and energy whereas sweaters and warm beverages provided the physical sensation of comfort. While it can be argued that some of the items in this grouping met functional needs, they fall into a category of sensory artifacts or rituals. Because so many of these sensory artifacts are cited as contributing to empowerment, I infer that comforting sensory qualities are of high importance when designing for empowerment. Items that reportedly created the sensory experience of empowerment are shown in fig. 15.


Figure 15. Research Probe Results: functionally empowering items (left) and empowerment through sensory experiences (right). Photos by Laurence Wong.

(iii) *Psychological Empowerment:* "symbolic of an empowering experience"

Two groups of object were identified as being symbolic of empowerment. The first group of items included items such as bank cards, a weight scale and a baking pan. The items were reported to *represent* the empowerment they felt from being financially secure, being healthy or feeling accomplished through baking. The other grouping illustrates items that reportedly provided empowerment through the objects' *visual appearance* such as colour, shape or visual style. For example, the colour red appeared in several objects that were described as being active and energized.


Figure 16. Research Probe Results: items symbolizing empowering experiences. Photo by Laurence Wong.

iv) *Ideological Empowerment*: "self-expression"

I relate the use of objects as method of self-expression to *ideological empowerment* since the object is representing the participant's personal qualities, attitudes, beliefs or ideology . A common trend amongst the participants of the probe was that being able to expression themselves or make a statement against social pressures is an empowering experience. Tattoos, unique clothing items and the selection of vibrant colours were photographed to represent the participant's individuality (see fig. 17.).


Figure 17. Research Probe Results: empowerment through self-expression. Photo by Laurence Wong.

Other Noteworthy Trends:

Several similar items were reported to be empowering and were grouped into the following sets of images. For example, eyeglasses were photographed by 3 of the 7 participants; however, one participant said they were worn "to appear more intelligent to others in the workplace" whereas another participant said they empowered her because "without my sight I felt powerless." Although similar items can be grouped together, they often represented different experiences related to empowerment for different people. Therefore, empowerment from an object isn't based solely on the object but also involves the meaning and experiences associated with the object as well.

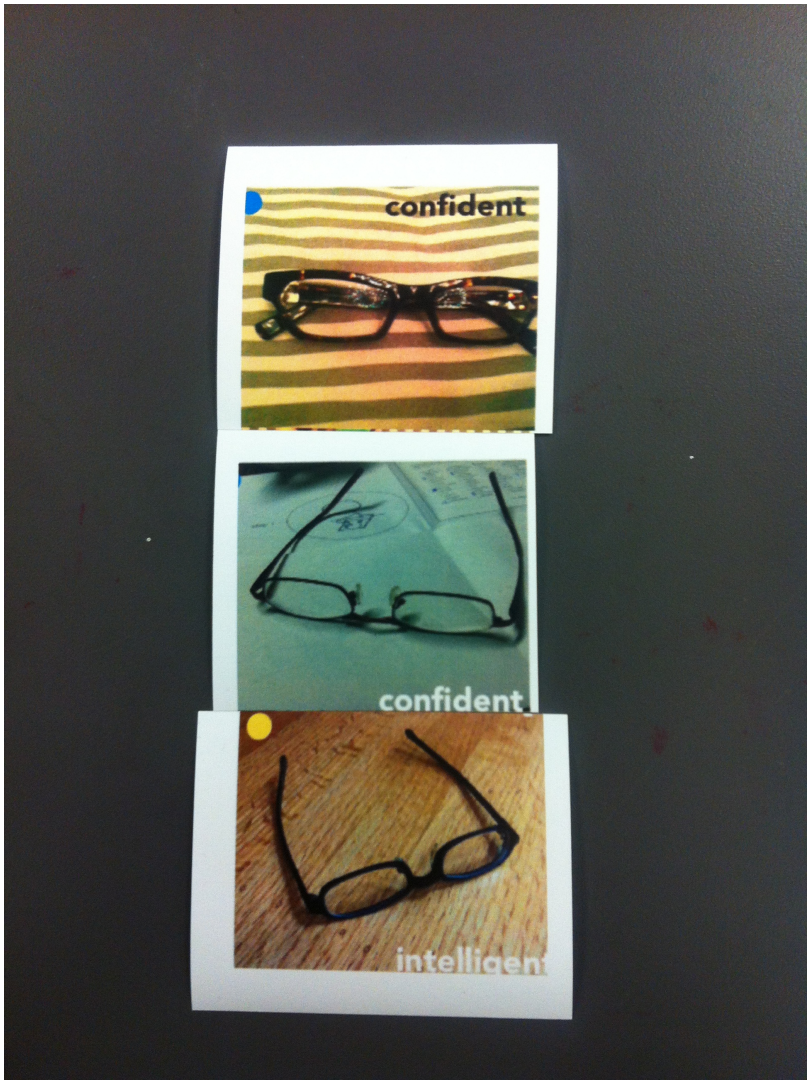


Figure 18. Research Probe Results: the different reasons glasses are empowering. Photo by Laurence Wong.

The final method of analysis was to study the physical qualities of all the items photographed for a particular word to determine how the design features and appearance may contribute to empowerment. Once the formal analysis of the word descriptors, photographs and comments for each participant was completed, additional inferences were made to interpret the findings in a more meaningful way so they can be extrapolated and applied to my thesis' case study, Shoulderwear, the re-design of a women's shoulder support.

# 4.0 ANALYSIS

The following summary of findings and guidelines was derived from the results of the research probe on empowerment through objects. Although the application of the research findings will be limited due to the small sample size, notable trends were observed and summarized in the sections below.

## 4.1 Summary of Key Findings

*Trends*

Consistent with the holistic approach in empowerment described in Section 2.2, the comments submitted by participants reported empowering experiences that fall within the four types of empowerment but are described as self-expression, sensory experiences, empowering experiences, attracting attention from others and effective functionality. These descriptors of empowerment are comparable to ideological empowerment, physical empowerment, social empowerment and psychological empowerment. A detailed summary of these key trends is provided in the following sections.

i. Items allowing the opportunity for ***self-expression*** was the most common form of empowerment documented in the probe. From the 71 photographs and comments submitted by the participants, 37 items were reported to be used to express their personality in some manner. For example, items with bright colours were photographed on many occasions where the object was used to describe empowerment but not in the same manner for everyone. Helen has bright coloured hair and bracelets that represents her personal style. Shauna's tattoo is another example of feeling empowered through some form of self-expression.

   *Design guideline*: when looking to generate empowerment for women through design the object should consider creating a user experience or having a visual appearance that can represent some aspect of the user's ideology: their personality, attitudes, beliefs, or lifestyle.

ii. Empowerment was often related to tactile and other ***sensory qualities***. From sensory experiences participants reported feeling comfortable, strong, energized and confident. For example, the participant Zoe reported feeling confident when she wore her favorite pair of jeans because she felt so relaxed and comfortable in them.

*Design guideline*: the selection of material should aim to stimulate users' senses in an empowering manner. I consider empowerment through sensory experiences as a form of *physical empowerment*.

iii. Twenty four items representing ***empowering experiences*** were photographed but the objects themselves had little value to the participants. For example, Shauna photographed a baking tray because it represented an empowering activity (baking) that resulted in a sense of accomplishment.

*Design guideline*: designing a positive user experience may lead to empowering experiences or *psychological empowerment*.

iv. Eighteen items photographed by participants were reportedly chosen because they increased self-confidence by ***attracting the attention of others***. For example, three participants reported feeling more confident when they wore their favorite jewelry items but they gained additional confidence when they received compliments from others.

*Design guideline*: designing a rehabilitation device that attracts positive attention from others is empowering because it reinforces self-confidence. I relate empowerment through the attention of others as *social empowerment*.

v. Fulfilling ***functional*** requirements is the foundation for any rehabilitation device, but empowerment was reported by participants when items performed their functional tasks exceptionally well. Helen described feeling empowered through the use of her compression socks because they were so effective in assisting the circulation around her feet and ankles.

*Design guideline*: in order for rehabilitation devices to empower users they must perform their function effectively and reliably. I relate effective functionality of a rehabilitation device as a form of *physical empowerment*.

## 4.2 Key Points

- Empowerment can occur through objects.
- There were common verbal descriptors that research probe participants related to empowerment with the five most consistent terms being confident, happy, energized, active and unique.
- There were also common objects photographed by participants to represent some form of empowerment. The most frequent items were articles of clothing, footwear, fitness gear, and jewelry.
- Design attributes that were reported to empower research probe participants were more related to sensory and personal experiences than the object's form or function.
- Ways in which objects can facilitate the sense of empowerment include the following: positive user experiences; enabling the user; generating positive attention in public; and allowing the user to express her personality.

## 4.3 Insights for Empowering Women Through Design

i. The design should allow the opportunity for ***self-expression***: *ideological empowerment*.

ii. The design should include ***sensory qualities*** that women have identified as empowering: *physical empowerment*.

iii. The design should represent ***experiences*** that women relate to empowerment: *psychological empowerment*.

iv. The design should have design qualities that invite ***positive attention*** from others to provide additional confidence: *social empowerment*.

v. The design should fulfill its ***functional*** requirements effectively and reliably: *physical empowerment*.

The insights gained from the research probe yielded design guidelines that provide a platform for this thesis' case study, the re-design of a women's shoulder support with empowering design attributes to create *Shoulderwear*.

## 5.0 SHOULDERWEAR: A CASE STUDY

## 5.1 Design Brief

This case study looks at the redesign of a shoulder support for women as it transitions from a design process that is rooted in expected design activities, such as design research, biomimetic study, and extensive prototyping, and then evolves to Shoulderwear as the empowerment principles are developed and applied to the project.

I chose the re-design of a shoulder support for women as a case study to investigate how research findings and insight can be applied to a body-worn rehabilitation product. The problem space for conventional shoulder supports is that they tend to reinforce the fact that the wearer has a physical disability due to the heavy visual language and use of medical grade materials. The reinforcement of a disability, whether it is a short or long term, is problematic within the rehabilitation process since prolonged compensation or overprotection of the shoulder can lead to a sense of "learned disability". The anxiety over further injury, pain or perceived disability can lead to further disuse of the arm, delaying the return of shoulder strength and mobility. Further, learned disability of the shoulder can result in subsequent conditions such as frozen shoulder syndrome (adhesive capsulitis) where scar tissue develops and physically restricts the shoulder joint until it is broken down by a physiotherapist and a rigorous exercise regime. In older age groups lack of use may contribute to an accelerated loss of bone density of the shoulder blade and arm, making them more susceptible to fractures. This is an opportunity to design shoulder support that encourages users to perform appropriate activities with their shoulder, and in parallel, to explore the potential of design for empowerment.

Women over the age of 18 were chosen as the target user group because market research identifies that most current shoulder supports do not take into account women's breast tissue, undergarments, or the anthropometric differences between men and women. There is also uncertainty over whether the appearance of current shoulder supports and their resemblance to athletic equipment from contact sports, like hockey and football, is consistent with the empowering design features preferred by most women.

## 5.2 Biomimetics Research

> "Biomimetics is the study of the structure and function of biological systems as models for the design and engineering of materials and machines" (Oxford Dictionaries Online).

> "Biomimetic design uses biological phenomena as inspiration for solutions to engineering problems" (Chiu and Shu 45).

I performed an extensive review of the shoulder anatomy and biomechanics to identify all the key structures of the shoulder joint and the role each plays in securing the ball against the socket at rest and during movement. The anatomical structures that I reviewed included the bones, cartilage, ligaments, muscles and nerves. Research included reviewing anatomy textbooks and sketches that analyzed each layer from the deepest at the bone level to the muscles closest to the surface, as seen in the images below. I also reviewed the biomechanics of the shoulder, neck and upper arm (see fig. 19.) and I documented the muscle forces around the shoulder in an image of a torso with arrows drawn to show the direction of pull by each muscle (see fig. 20.).

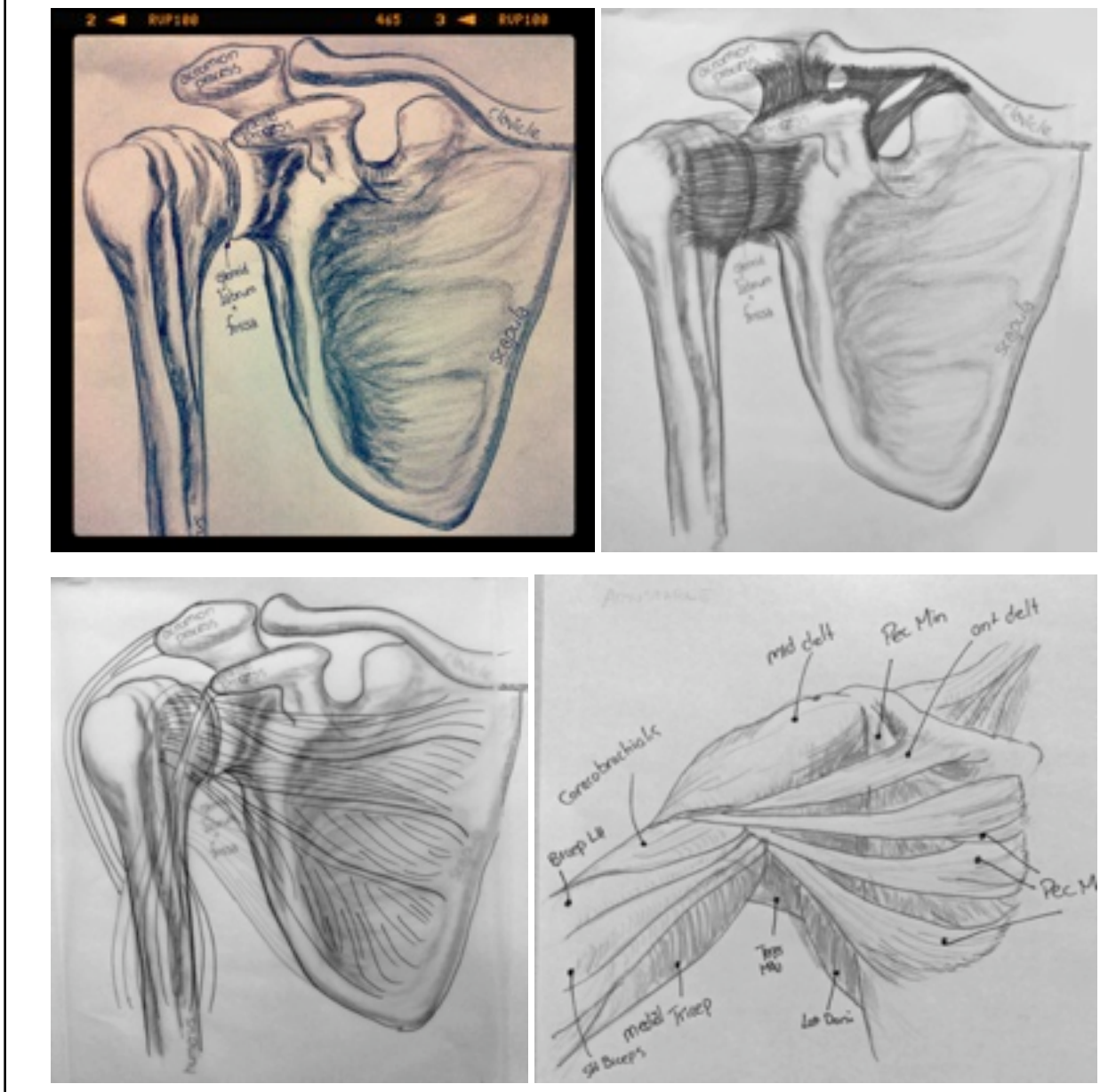


Figure 19. Biomimetics Research: sketches of superficial and deep muscles of the shoulder. Photos and images by Laurence Wong.

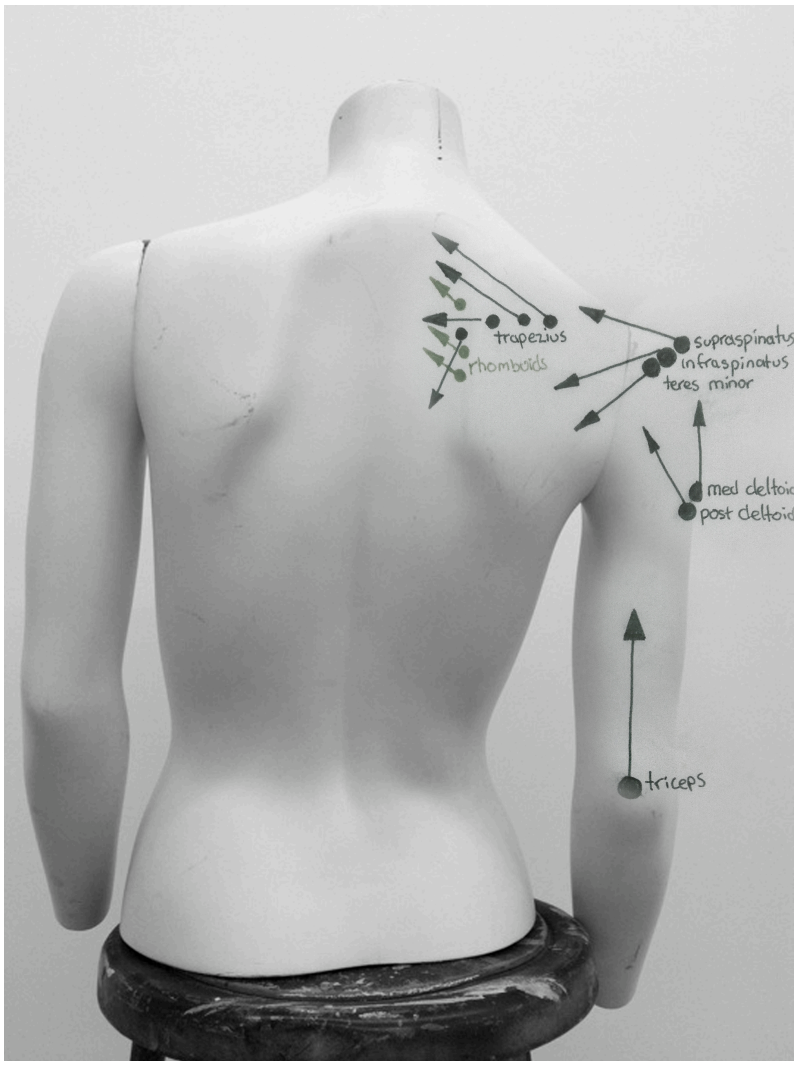


Figure 20. Biomimetics Research: image of posterior shoulder muscles and their stabilizing forces. Image by Laurence Wong.

Other studio research related to anatomy included sketching on a model to identify the location of the muscles underneath the skin and applying athletic tape that replicates the stability provided by muscles (as seen in the following set of images). Finally, I performed a review of the most common medical conditions associated with shoulder instability with physiotherapy textbooks and notes from post graduate courses.


Figure 21. Biomimetics Research: shoulder muscles drawn on the skin surface of a model. Photo by Laurence Wong.

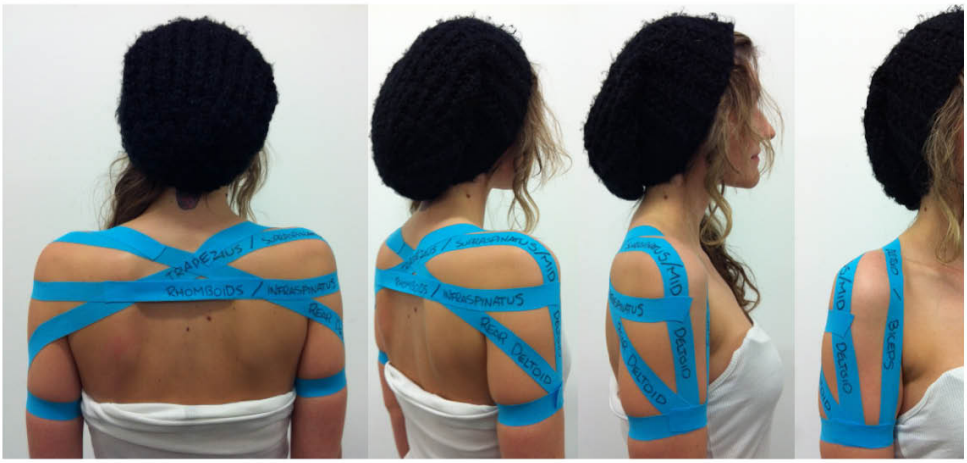


Figure 22. Biomimetics Research: taping technique replicating muscle stability. Photos by Laurence Wong.

APPLICATION OF FINDINGS

The review of anatomy, biomechanics and shoulder pathologies were all considered and integrated into the re-design of a shoulder support for women. The culmination of findings led to my conclusion that a wearable shoulder support should attempt to replicate the key muscle forces that stabilize the ball against the socket and help to properly position the shoulder blade. Conventional shoulder supports contribute to the downward rotation of the shoulder blade and the shoulder socket. In this position gravity will pull the ball away from the socket whereas the upward rotation of the shoulder blade and the socket uses gravity to pull the ball into the socket for better joint stability.

The findings from research on anatomy, biomechanics and shoulder pathologies has led to a design with biomimetic components that will replicate natural muscle stability forces. The final specification calls for support bands integrated into the design to aid unloading arm weight and to stabilize the ball against the socket during rest or with basic shoulder movements. The support bands are oriented in a similar fashion as the biceps, triceps, deltoids and rotator cuff muscle groups of the shoulder.

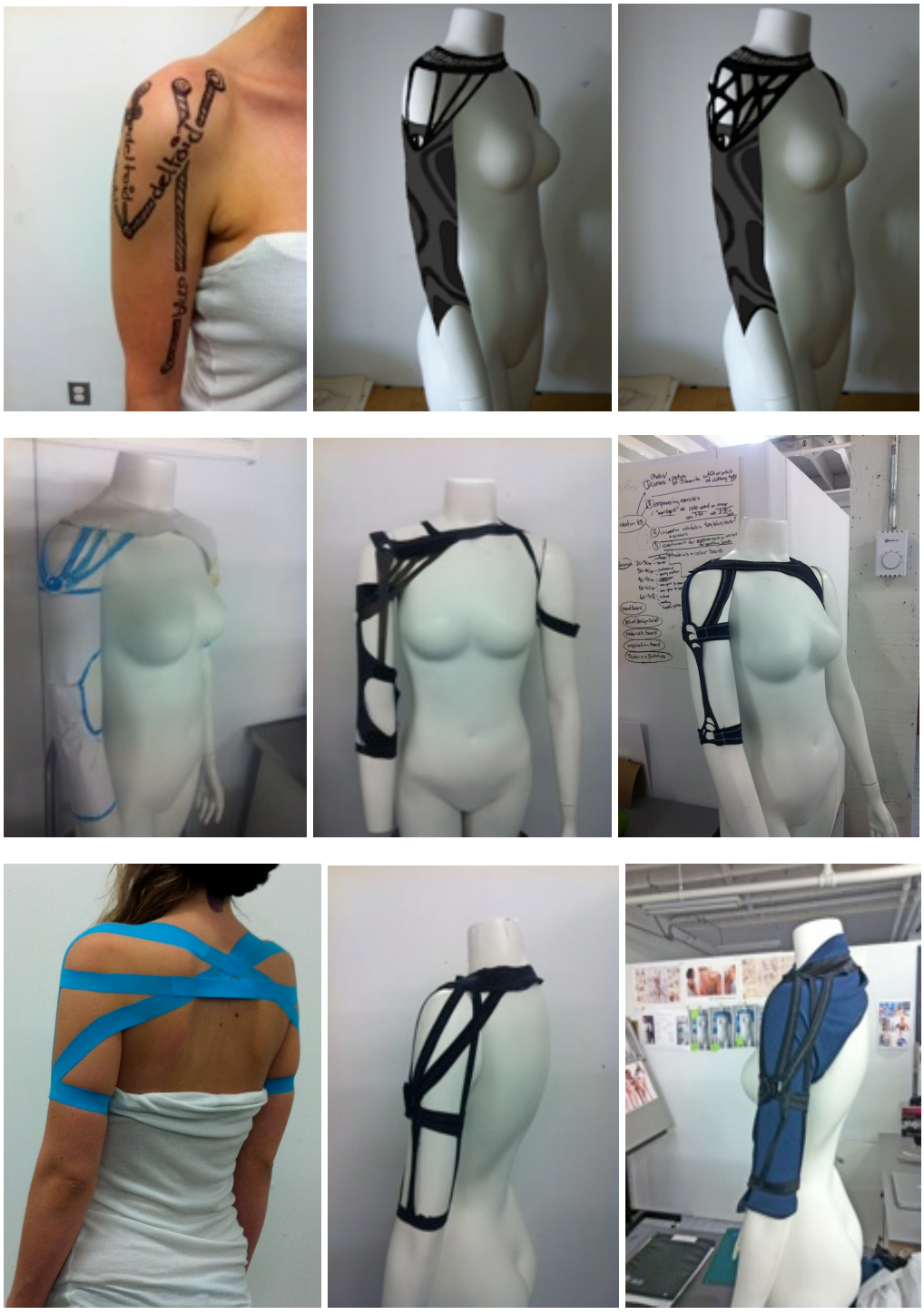

Figure 23. Biomimetic Research: progressing from a skin surface drawing to mock-ups of the stability system. Photos by Laurence Wong.

## 5.3 Exploring Empowerment in the Studio

RESEARCH ACTIVITIES

Studio research into a fashion-driven design language was conducted concurrently with the research probe, and consisted of 2D sketching, 3D sketching, mock-ups and user testing of prototypes to gather information for the design development.

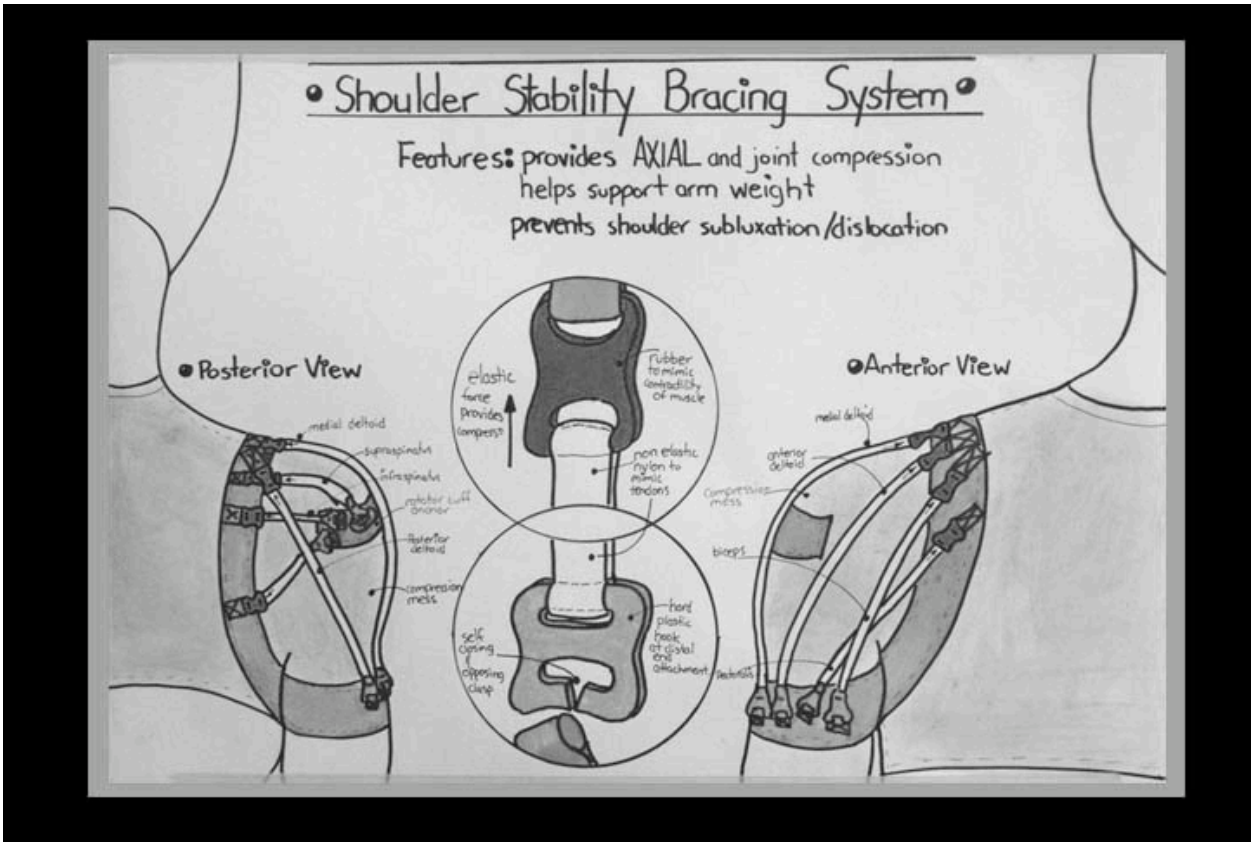


Figure 24. Designing Shoulderwear: this was the initial concept looking to replicate muscles within a shoulder support. Image by Laurence Wong.


Figure 25. Designing Shoulderwear: experimenting further with counter balancing and looking at asymmetrical design with a softer form and moving away from literal biomimetic design interpretations. Photos by Laurence Wong.

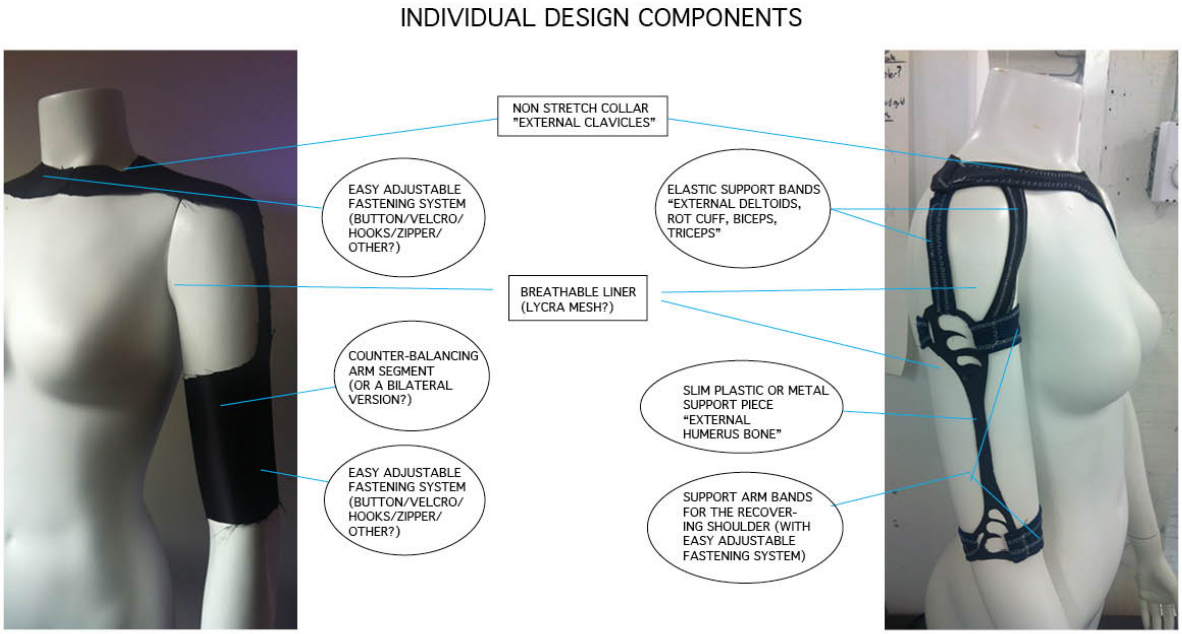


Figure 26. Designing Shoulderwear: a break down of each component and the key features that will be designed to facilitate empowerment as my final prototype. Photos by Laurence Wong.

Figure 27. Designing Shoulderwear: early 3D sketches or mockups illustrating how the support bands can be situated externally on a garment. The bands represent the orientation of key shoulder muscles. While the development at this stage is very pragmatic, these mockups indicate the design intent to make the structure visible.  Photos by Laurence Wong.

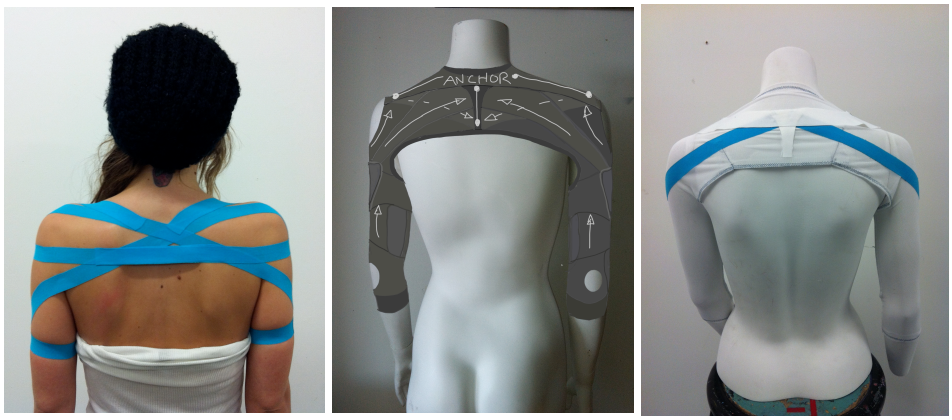


Figure 28. Designing Shoulderwear: further design sketches looking at a shoulder support design that incorporates both arms and has a more universal application for posture correction, high performance sporting apparel or as a fashion accessory. Photos by Laurence Wong.

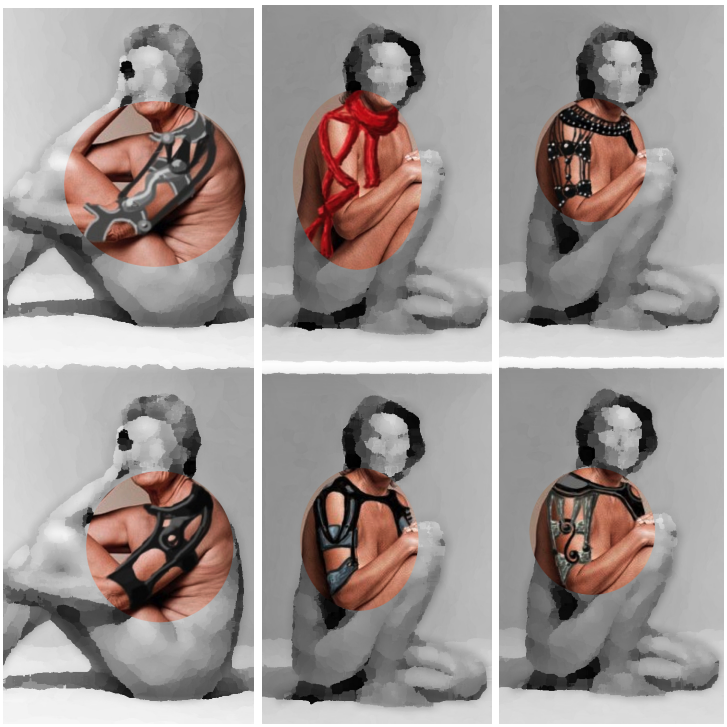

Figure 29. Designing Shoulderwear: further exploration into minimal use of materials while maintaining key stability components with variations in detailing. These designs were considered unsuccessful for the demographic that was portrayed, but they led to the evolution of several design concepts that were fruitful. Renderings by Laurence Wong (portions of the images above have been modified due to copyright restrictions).

Figure 30. Designing Shoulderwear: sketches of fun and provocative designs that took into account how the shoulder support would be worn under a bra. Inspiration for these sketches came from tattoo images and themes. Renderings by Laurence Wong (portions of the image above have been modified due to copyright restrictions).

Figure 31. Designing Shoulderwear: dance and yoga inspired concepts concealing support bands externally but is a design feature integrated into the lining. Photos by Laurence Wong.

## 5.4 The Developed Prototype

From Shoulder Support to Shoulderwear is a case study of how empowerment principles can impact the design of a rehabilitation device for women with shoulder instability. Findings from the research probe provide support that common empowering design experiences include social, physical, psychological and ideological elements. Although in physiotherapy the physical empowerment, through functionally enabling a client, is the first priority, the subsequent forms of empowerment have a significant role in enhancing clients' quality of life overall. In developing Shoulderwear that meets these descriptors of empowerment, extensive iterations were explored to find the form or fashion driven design language that suggests the shoulder support will be comfortable yet strong, unique yet professional and sophisticated and will provide confidence which can free wearers from being self-conscious about their appearance and from fear of insufficient shoulder support. The rendering of the shoulder support is a sample design concept consisting of many elements that will be incorporated into the Thesis Project's final prototype. Equal emphasis will be placed on *user experience* which encompasses comfort, support, fashion language and usability to address the empowering design attributes identified from the research probe. In the final prototype of Shoulderwear the fabric material will likely be similar to high quality performance garments currently used in high performance cycling, yoga and other athletic garments to provide support and comfort (utilizing the lightness, breathability and durability of Lycra while possibly including a cotton or bamboo blend for improved comfort). The selection of material will look to create a positive sensory experience in promoting *physical empowerment*. A biomimetic support band system that replicates natural muscle forces will provide better positioning of the shoulder blade and stabilization of the shoulder joint. The improved functionality through biomimetic design will be another form of *physical empowerment*. To provide an opportunity for self-expression, *ideological empowerment*, a fashion driven design language will be integrated into the design of Shoulderwear along with a selection of styles to choose from. Creating an overall positive user experience will promote *psychological empowerment* where the user may feel empowered because of the reliability, comfort, positive attention, support, representation of their personality or the combination of all these experiences.

Figure 32. Designing Shoulderwear: a preliminary rendering of a developed prototype. Rendering by Laurence Wong (portions of the image above have been modified due to copyright restrictions).

# 6.0 CONCLUDING THOUGHTS

## 6.1 Implication for Designers of Rehabilitation Products

Based on my experiences as a physiotherapist, facilitating empowerment in clients through design would make an important contribution to their overall health and wellness. The several levels of needs identified by Abraham Maslow (from safety to esteem, acceptance and belonging) can be addressed through design so that rehabilitation products aid people in meeting these needs. The expansion in the understanding of pleasure offered by Jordan led to the consideration of four categories of empowerment: *physical empowerment, social empowerment*, *psychological empowerment* and *ideological empowerment*. The professional practice of physiotherapy attempts to empower clients physically and psychologically. However, all four categories of empowerment may be addressed through the inclusion of empowering design qualities into rehabilitation products. For example, Shoulderwear will be physically enabling, reassure wearers of its support through its biomimetic design (*psychological empowerment*), invite positive attention in the public realm (social empowerment), and allow the wearer to express her personal style (*ideological empowerment*).

With the affirmation from research probe findings that objects possess the potential to empower their users, the design goals for rehabilitation products can include design qualities that facilitate empowerment. It is imperative that designers involve the client (or user) in the design process to ensure that empowering design qualities are identified for different user groups.

## 6.2 Implications for the Rehabilitation Process and Medical System

Designing rehabilitation products that facilitate the sense of empowerment may improve the rehabilitation outcomes of clients. Empowering design features increase the likelihood that clients will comply with rehabilitation exercises or use their assistive devices (such as splints and braces) consistently. Designing a better user experience may help prevent the prolonging of the client's recovery that often occurs due to avoiding the rehabilitation

devices or equipment due to embarrassment, discomfort, or a tedious user experience. When rehabilitation products are prescribed to improve the safety, this increased compliance can help prevent further injury. When design contributes to the prevention of further injury, or aids in achieving the shortest rehabilitation time, the health care system benefits greatly in terms of reduced medical costs covered by the government and allows more time for health care professionals to attend to clients.

### 6.3 Implications for Persons with a Physical Disability

The greatest impact of designing to facilitate empowerment is that the client's quality of life can be improved through the use of their rehabilitation product. The goals of health care professionals working with individuals with long term or permanent disabilities, such as stroke or spinal cord injuries, is to provide the highest quality of life possible for the client. Physical therapists do so by maximizing the client's physical abilities and prescribing assistive devices or rehabilitation products, and through practices that encourage empowerment. Since manufacturers of rehabilitation products tend to focus on the engineering features, the role of design is often overlooked. Countering this with an understanding of the importance of empowerment could increase the role of designers in this process, with a resulting increase in the quality of rehabilitation products and the quality of life for clients.

Good design can reduce the unwanted attention or stigma around the client's disability while also drawing the client's own attention away from his/her disability through empowering design qualities. The end result can be a facilitation of the acceptance of a disability by the client or even having the client embrace the disability as a part of his/her identity and proudly displaying their disability with an empowering rehabilitation product.

## 6.4 Questions for Further Research

This research clarifies the important role of empowerment in rehabilitation products, and makes the case for further research into how products can empower clients. Most significantly, a more detailed research probe should be conducted with a larger study group to substantiate the findings of the research done for this thesis. In addition, several questions could be addressed in further research.

- Does the interpretation of empowerment differ between men and women?

- Does the interpretation of empowerment differ between cultures?

- Will the inclusion of empowering design attributes into a rehabilitation device generate the sense of empowerment in the wearer?

- How can empowerment from a rehabilitation device be measured?

- Can design attributes that empower clients be applied to other rehabilitation devices?

## 6.5 Conclusion

In conclusion, the thesis study identified that objects have the capacity to empower users through specific design attributes. The application of these attributes was explored through a case study to create Shoulderwear for women, a fashionable and empowering rehabilitation device to stabilize the shoulder joint.

The results of the Empowerment Research Probe supports the notion that a sense of empowerment can occur from certain objects I explored. The analysis of these results provided a deeper understanding of how empowerment was gained through experiences

with the items participants deemed special. The insights from the analysis of the probe were then used to clarify design goals for the Shoulderwear case study.

This thesis demonstrates that feeling empowered is important to wearers of rehabilitation products, and that empowerment principles can be successfully applied to design artifacts. Further, it offers specific insights that can lead to well designed rehabilitation products and a greater appreciation for design in the empowerment of users with physical disabilities.

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## APPENDIX A: Letter of Invitation & Consent

emily carr
university of art + design

1399 Johnston Street, Vancouver, BC, Canada V6H 3R9

**Office of Research & Industry Liaison**
EMILY CARR UNIVERSITY RESEARCH ETHICS BOARD (ECU-REB)

Invitation / Consent Form

Date:

Project Title: **Biomimetic Design in a Shoulder Support**

Principal Student Investigator:
Laurence Wong, BSc.PT, MAA (candidate)

Emily Carr University of Art and Design
(604) 889-5733, lwong2844@ecuad.ca

Other Researchers:
Louise St. Pierre
Faculty Supervisor
Faculty of Industrial Design

Emily Carr University of Art and Design
(604) 844-3800, lsp@ecuad.ca

INVITATION

You are invited to participate in a research study. The purpose of this study is to identify the desirable design aesthetics of wearers that can be applied to a design of a shoulder support that replicates the natural stabilizing forces of muscles.

WHAT'S INVOLVED

As a participant, you will be asked to identify 10 words you identify most with the term *empowerment*. Then a you will be instructed to photograph an object that best represents each word you selected. Finally, written comments are encouraged to describe how each item empowers you . Participation will take approximately 45 minutes.

POTENTIAL BENEFITS AND RISKS

The possible benefits for the participant is the knowledge that they will be contributing to the design and rehabilitation communities. The participant may also acquire a better understanding of empowerment through design. The risks associated with participation is expected to be similar to getting dressed and light office work. Therefore, the risk is no greater than what is encountered in daily activities.

CONFIDENTIALITY

Personal identifiable features collected during the course of the research (e.g., names, initials, addresses, birth dates, organizational names and titles will be not be used unless consent is given with a Model Release Form. Faces and other recognizable characteristics will be blocked out or blurred unless consent is received with a signed Model Release Form.

**This form DOES NOT include the provision for Assent and Consent of participants who are minors or who are under legal guardianship. A TEMPLATE Release Provision for Minors or Others Under Guardianship is available for this purpose from the ECU-REB.**

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## Office of Research & Industry Liaison

EMILY CARR UNIVERSITY RESEARCH ETHICS BOARD (ECU-REB)

All written records, video/audio tapes, and questionnaires will be stored in a locked storage container and kept in a secure building at Emily Carr University. At the conclusion of the research project, the confidential data collected during this research, including your contact information, will be securely stored at Emily Carr University for 5 years, after which time it will be destroyed in a secure manner. Access to this data will be restricted to Laurence Wong (Principle Investigator) and the Faculty Supervisor.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time, or to request withdrawal of your data. You may do so without any penalty or loss of benefits to which you are entitled.

PUBLICATION OF RESULTS

Results of this study may be published in reports, professional and scholarly journals, students thesis, and/or presentations to conferences. This research may result in a product that is available in both academic and commercial contexts. In any publication, data will be presented in aggregate forms. Quotations from interviews or surveys will not be attributed to you without your permission. Images of you will not be published without your permission.

Feedback about this study will be available from the Principal Student Investigator (Laurence Wong) via e-mail or by telephone as listed at lwong2844@ecuad.ca or (604) 889-5733. Feedback will be available at the completion of the research project in May 2013. At that time you will also be invited to the project's Thesis defence and exhibition. Furthermore, a 1-2 page project summary document will also be sent upon completion of the project.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact the Principal Student Investigator (Laurence Wong) or the Faculty Supervisor (Loiuse St. Pierre) using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at the Emily Carr University of Art and Design [ECU-REB File# 2012041302 approved November 12th, 2012]. If you have any comments or concerns, please contact REB Assistant, Lois Klassen at ethics@ecuad.ca

**This form DOES NOT include the provision for Assent and Consent of participants who are minors or who are under legal guardianship. A TEMPLATE Release Provision for Minors or Others Under Guardianship is available for this purpose from the ECU-REB.**

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## Office of Research & Industry Liaison

EMILY CARR UNIVERSITY RESEARCH ETHICS BOARD (ECU-REB)

CONSENT FORM

I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Name: _____

Signature: _____Date: _____

Please sign both copies and keep one for your own personal record. Thank you for your assistance in this project.

**This form DOES NOT include the provision for Assent and Consent of participants who are minors or who are under legal guardianship. A TEMPLATE Release Provision for Minors or Others Under Guardianship is available for this purpose from the ECU-REB.**

## APPENDIX B: Digital Image and Audio Release Agreement


1399 Johnston Street, Vancouver, BC, Canada V6H 3R9

**Office of Research & Industry Liaison**
EMILY CARR UNIVERSITY RESEARCH ETHICS BOARD (ECU-REB)

Photo/Digital Image/Video/DVR/Audio/Digital Audio Recording RELEASE AGREEMENT

Date:

Project Title: **Empowerment & Biomimetic Design in a Shoulder Support**

Principal Student Investigator:
Laurence Wong, BSc.PT, MAA (candidate)

Emily Carr University of Art and Design
(604) 889-5733, lwong2844@ecuad.ca

Other Researchers:
Loiuse St. Pierre
Faculty of Industrial Design
Faculty Supervisor

Emily Carr University of Art and Design
(604) 844-3800, lsp@ecuad.ca

ECU-REB File# 2012041302

PROJECT DESCRIPTION The purpose of the **Empowerment & Biomimetic Design in a Shoulder Support** research study is to identify the desirable design aesthetics of wearers and apply them in a shoulder support that replicates the natural stabilizing forces of muscles while promoting a sense of confidence or empowerment.

CONTACT INFORMATION AND ETHICS CLEARANCE If you have any questions about this study or require further information, please contact Principal Student Investigator (Laurence Wong) or the Faculty Supervisor (Louise St. Pierre) using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at the Emily Carr University of Art and Design [ECU-REB File# 2012041302 approved November 12th, 2012]. If you have any comments or concerns, please contact REB Assistant, Lois Klassen at ethics@ecuad.ca .

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## Office of Research & Industry Liaison

EMILY CARR UNIVERSITY RESEARCH ETHICS BOARD (ECU-REB)

I will indemnify and hold the student, and the University, and its employees safe and harmless against any legal prosecution or suit arising from or prompted by the use of all or any portion of the material in which I am quoted or appear.

I am signing this release freely and voluntarily and in executing this release do not rely on any inducements, promises or representations made by said student or Emily Carrel University of Art and Design.

Name:_____Date:_____

Signature:_____

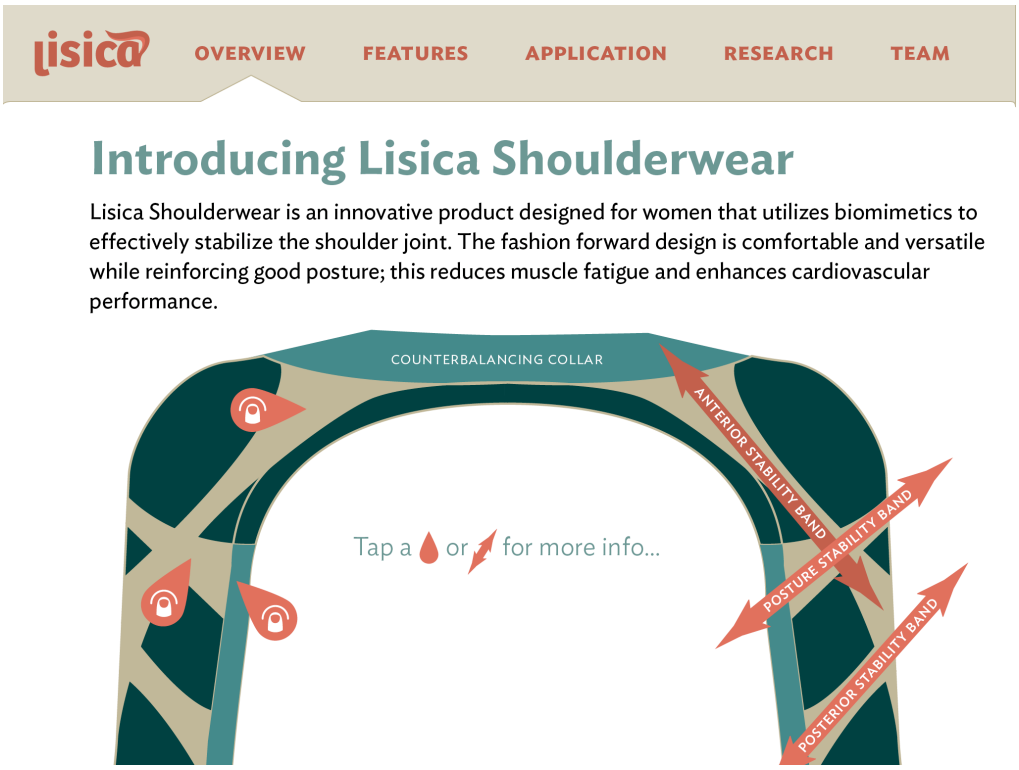
Witness Name:_____Date:_____

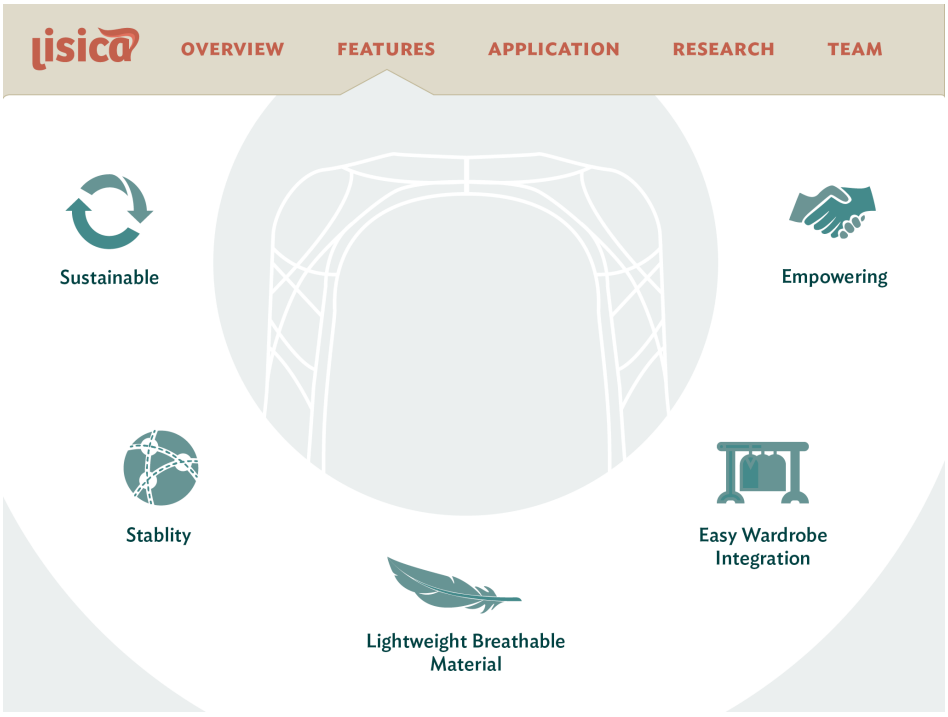
Signature:_____

Please sign both copies and keep one for your own personal record. Thank you for your assistance in this project.

**This form DOES NOT include the provision for Assent and Consent of participants who are minors or who are under legal guardianship. A TEMPLATE Release Provision for Minors or Others Under Guardianship is available for this purpose from the ECU-REB.**

## APPENDIX C: Lisica iPad Application and Website Pages (www.lisica.co.nf)



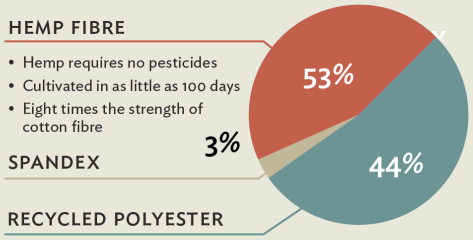
back

# Sustainable Materials

Lisica Shoulderwear uses fabrics made of recycled synthetic fibres and bamboo in its garments wherever possible.

| STRUCTURAL | SECONDARY |
|---|---|

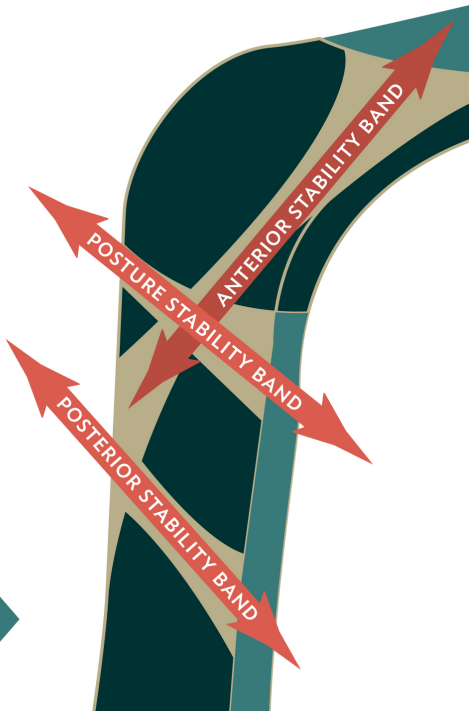
**Hemp / Recycled Polyester**



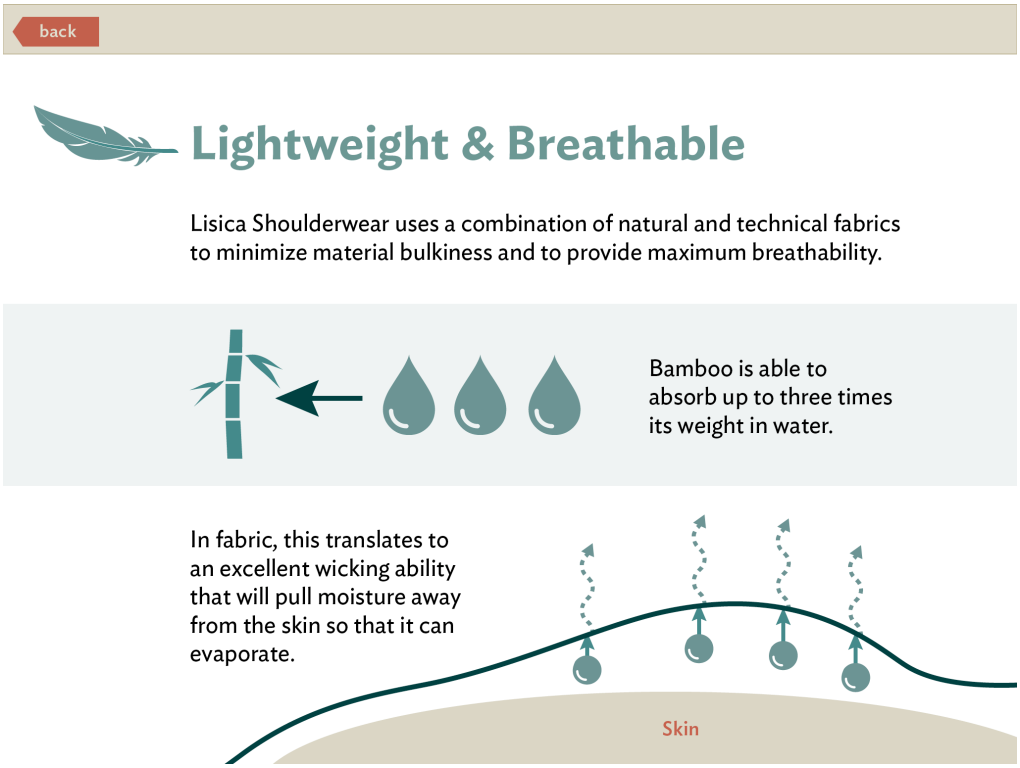

back

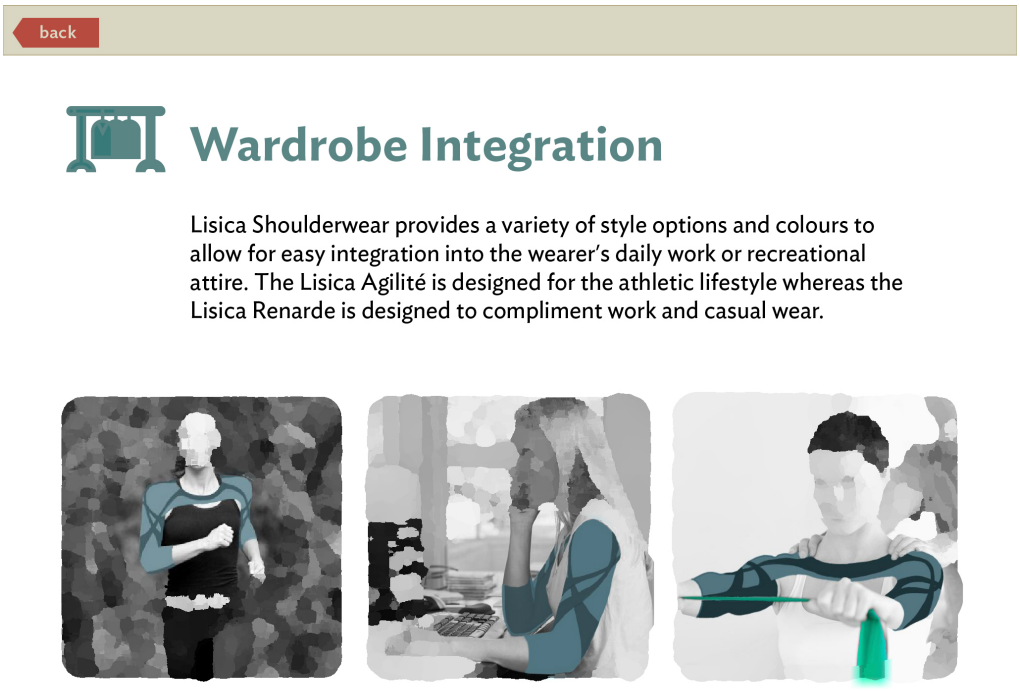
# Stability

Shoulder joint stability is achieved by integrating multiple direction specific stability bands. These stability bands replicate natural muscle forces holding the ball (head of the humerus bone) against the socket (the scapula's glenoid fossa and labrum).




learn more at **Biomimetic Research**

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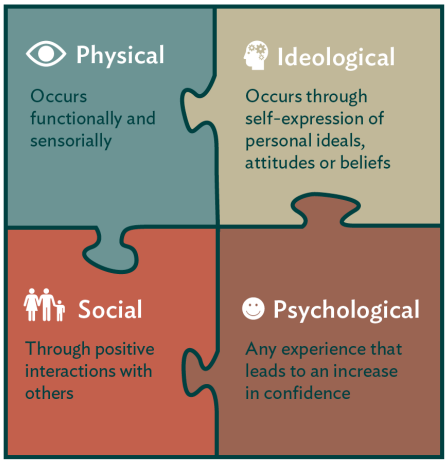
back

# Empowering

Lisica Shoulderwear is designed to foster an empowering user experience by providing a product that feels comfortable and supportive, stabizes the shoulder joint, represents different lifestyles; and compliments fashion. Relating the term 'empowerment' to design communicates to healthcare professionals the valuable role design can play in enhancing a client's overall quality of life.

*"empowerment in the health professions is the incorporation of an ideology concerned with choice and responsibility, skill development, and clients' quality of life."*

—AUJOULAT, ET AL. (2006)




see how at Design Research



## Rehabilitation

### Muscle Strains:

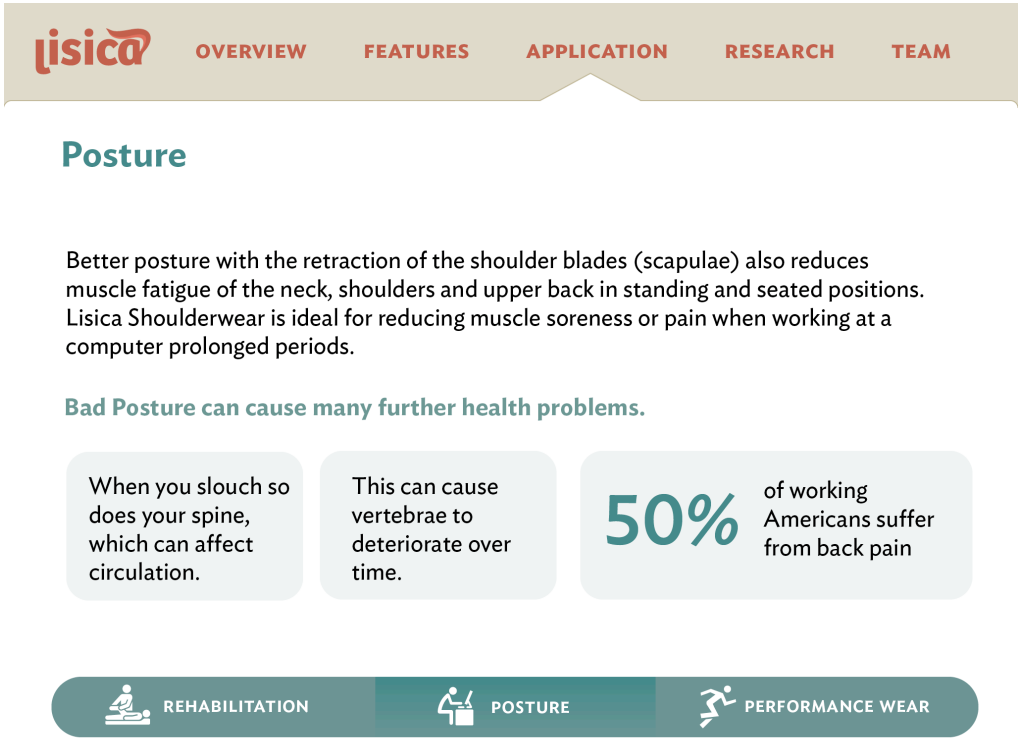
Having several multidirectional support bands in Lisica Shoulderwear provides active assisted shoulder support. Muscles are still able to regain the strength during the healing process while receiving partial assistance from the stability bands.

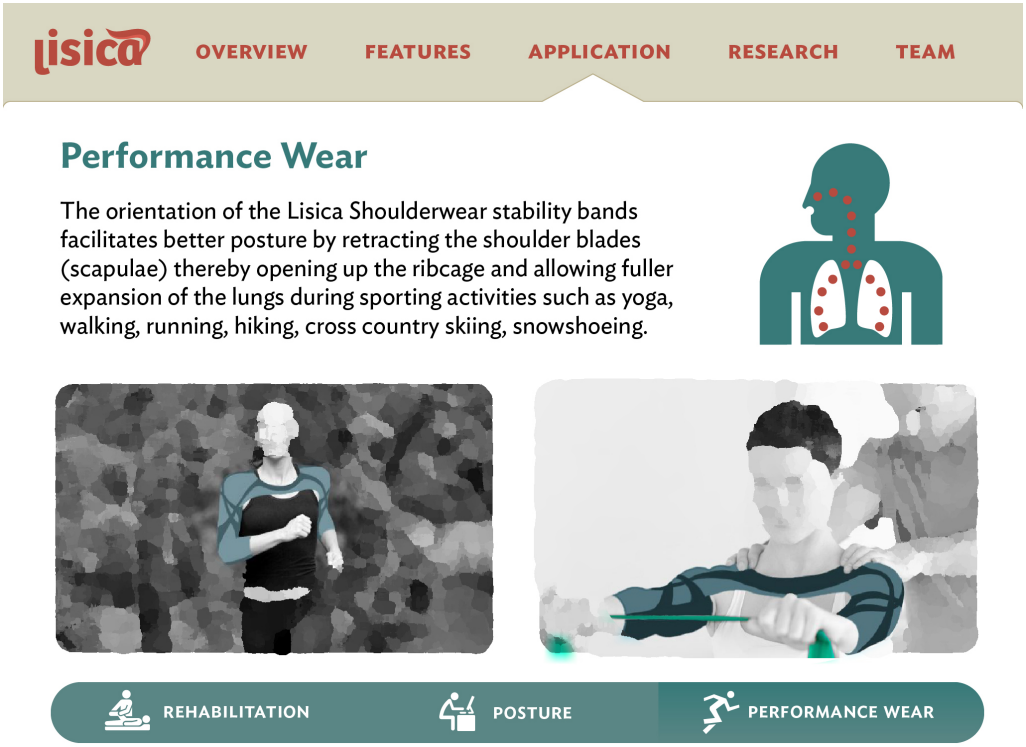
### Ligament sprains & shoulder hypermobility:

Multidirectional support bands in Lisica Shoulderwear provides support to injured or stretched ligaments around the shoulder joint in holding the ball against the socket . Facilitating the the stability of the ball and socket helps to reduce stress on healing ligaments after a sprain or dislocation.

### Post-stroke & nerve injuries

Lisica Shoulderwear is designed to aid the unloading of the upper arm through counterbalancing with the opposite arm weight by distributing the forces across the upper back and collar bones (clavicles). Reducing the tension on injured nerves helps them heal in the shortest time possible.

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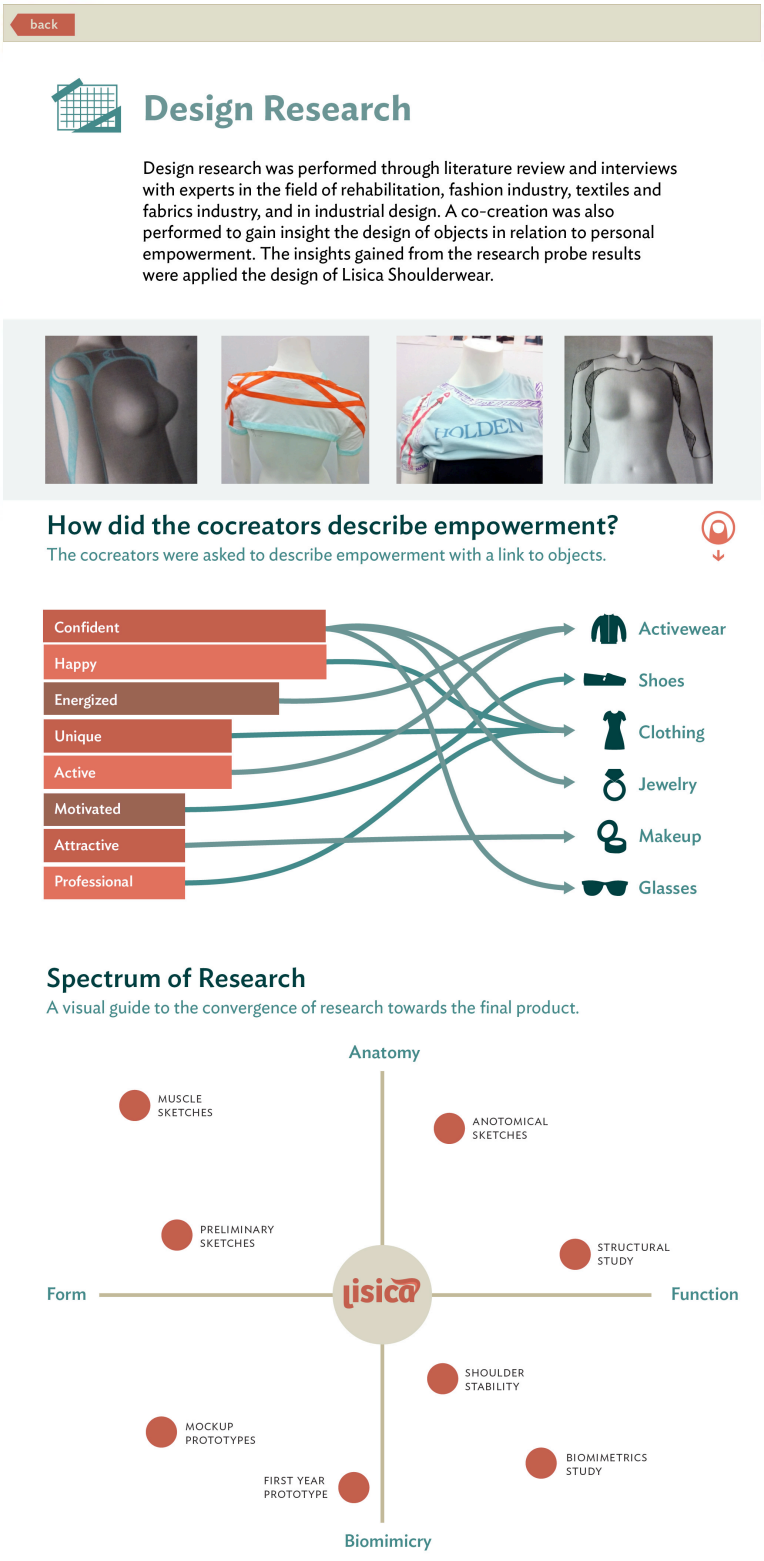



Photos by Laurence Wong.

back

# Medical Facts

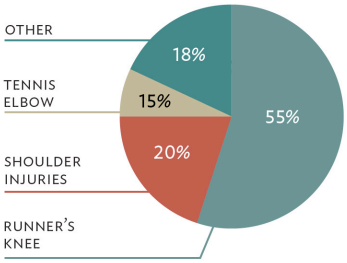
Extensive research was performed on the medical circumstances surrounding . The devices studied in detail and identified several design opportunities related to materiality, function, design language, and user experience.

**The shoulder is the most mobile joint in the body and therefore susceptible to instability**

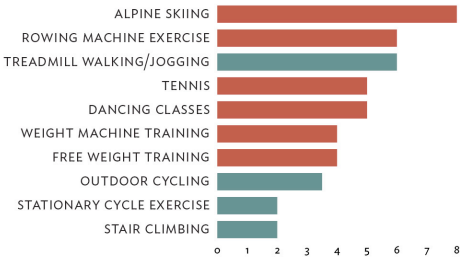
## How common are shoulder injuries?

Depending on the type of activities being measured, shoulder injuries can account for a significant portion.

The most common sports injuries




Injury Rates per hour of activity




## Shoulder Issues have other origins

Depending on the type of activities being measured, shoulder injuries can account for a varied portion.

**84%** of all stroke patients with hemiplegia will experience shoulder injury and pain.

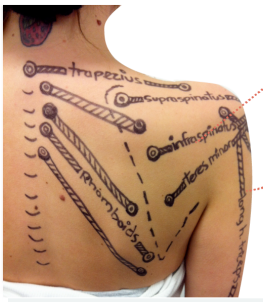
**50%+** individuals older than 60 years have at least a partial-thickness rotator cuff tear

The design of the lisica shoulder wear replicates rotator cuff muscle forces to compensate for hemiplgic shoulder pain and partial thickness rotator cuff tears, which are highly prevalent among the elderly population.

back

# Biomimetic Research:

The replication of natural muscle forces involved several methods of research that included a detailed review of anatomy, biomechanics, multiple design iterations (sketching, mock-ups, prototypes), and user testing before being integrated into the Lisica Shoulderwear.




The positioning of slected rotator cuff muscles originating from the shoulder blade and inserting at the top of the upper arm. These muscles aid to secure the ball against the socket of the shoulder.

The location of the deltoid muscles of the shoulder originate from the shoulder blade and inserting further down the outside of the upper arm.

**Research Photos** Tap to enlarge






lisica OVERVIEW FEATURES APPLICATION RESEARCH TEAM

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**Lead Designer**

## Nicole Barrett

Bachelor of Design (Industrial Design)
**Assistant Designer**

## Johannes Schut

Bachelor of Design (Communication Design)
**Interaction + Communication Design**

Photos by Laurence Wong, Nicole Barrett and Johannes Schut.

**APPENDIX D: Lisica Shoulderwear Variations and Design Features**



Photos and renderings by Laurence Wong (portions of the images above have been modified due to copyright restrictions).

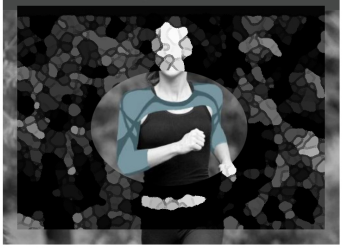
## injury rehabilitation

Lisica Shoulderwear provides a lightweight, breathable, and stylish alternative to traditional shoulder supports by utilizing selective fabrics and textiles to ensure optimum comfort, fit and function.

The Lisica Shoulderwear support system helps place the shoulder joint in proper alignment during arm movements through the replication of key rotator cuff muscles. The rehabilitation of shoulder injuries is facilitated through an "active assist" system where recovering muscles remain active while being partially supported.

Lisica Shoulderwear has been designed for prolonged use for chronic or as a fashionable accessory to preventing injuries and avoiding re-injury.

## aerobic performance

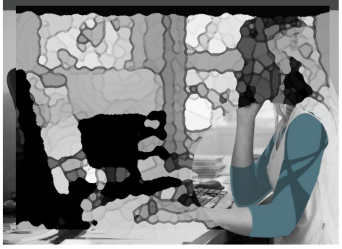


Lisica Shoulderwear's provides sensory biofeedback to key postural and rotator cuff muscles in facilitating the the expansion of the rib cage for improved air intake during aerobic activities.

Lisica Shoulderwear's partial unloading of arm weight provides additional benefits to endurance athletic performance by reducing the oxygen uptake and muscle fatigue of the neck, shoulder and upper back muscles.

Lisica Shoulderwear for the active lifestyle utilizes breathable, lightweight technical fabrics and the 3/4 sleeve and shrug design minimizes heat retention while allowing it to be easily integrated into any attire worn while exercising.

## postural support

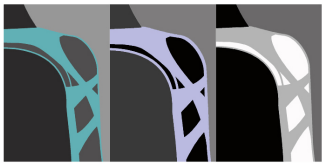


Lisica Shoulderwear's dynamic support band system "actively assists" weak and injured muscles of the neck, shoulder and upper back while in the standing and in the seated position.

Lisica Shoulderwear provides sensory biofeedback to key postural muscles that helps to prevent muscle pain and general fatigue by stimulating the activation of key postural muscles in maintaining optimal alignment of the spine.

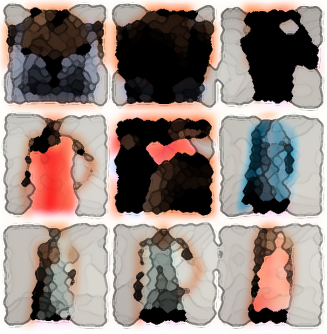
The body's silhouette is naturally enhanced through improved posture in the seated and standing positions.

# applications for lisica shoulderwear



*potential Lisica Shoulderwear colour variations based on design research from Lululemon Athletica activewear

lisica shoulderwear



**Design Qualities**:
•lightweight and breathable
•organic shapes and lines

**Fabrics:**
•Silverescent® material (bottom left), used by lululemon is infused with silver, is anti-bacterial and seamless
•COOLMAX® liner, luxtreme

**Textures & Stitching**:
•subtle contouring and flat stitching as well as contrast stitching

**Special Details**:
•accommodation or integration of undergarments (i.e. no limits tank combines bra with outer shirt, pump it up tank has a snap to hook bra strap in)

**Fit & Wear**:
• fit close to the body, allows for layering

LULULEMON

Laurence Wong & Nicole Barrett

# lisica variations for an **active** lifestyle

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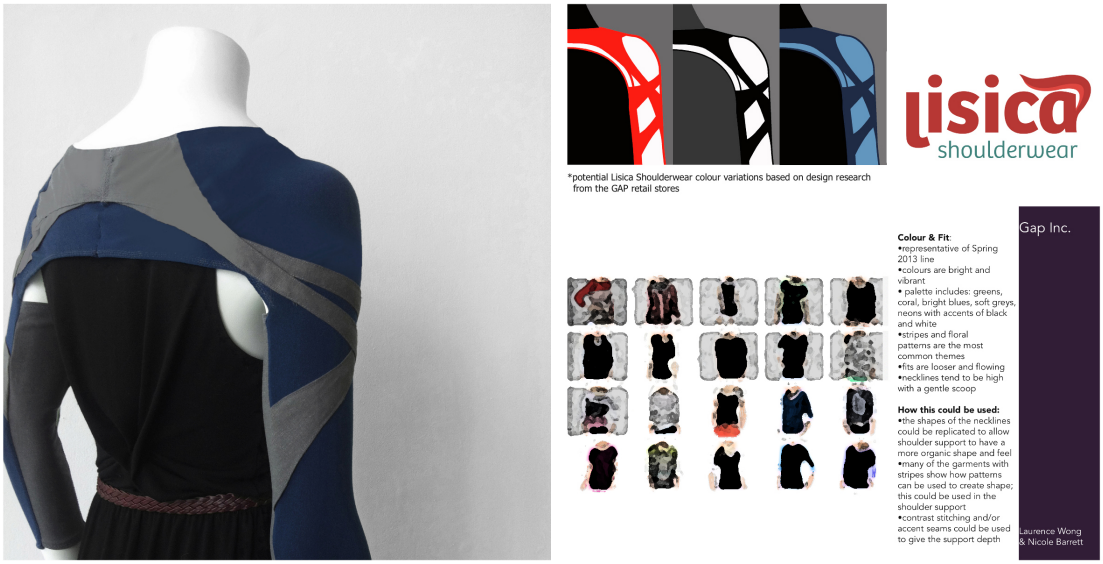
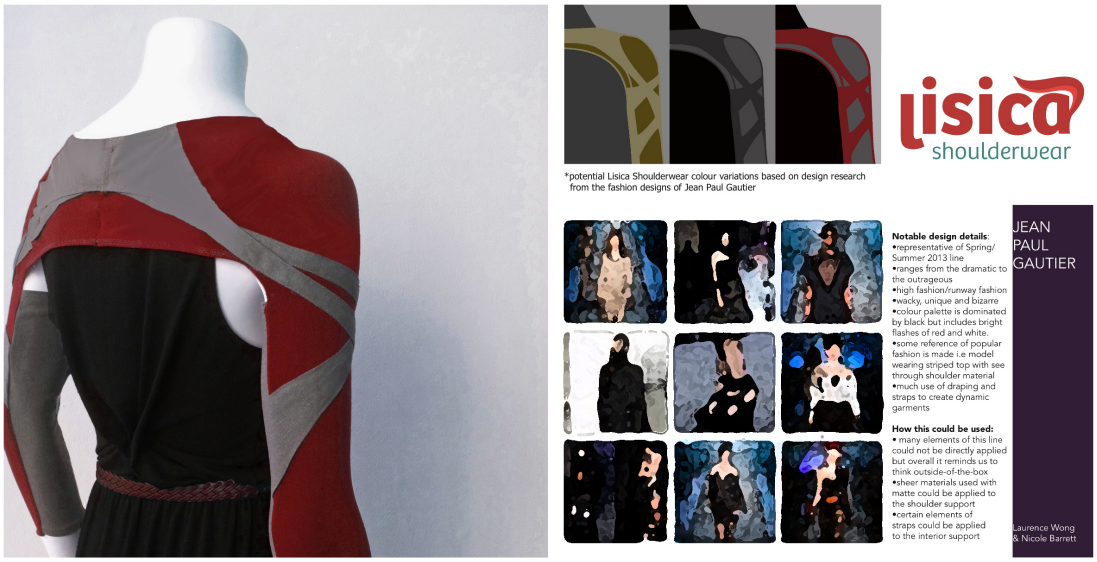



lisica variations for a **contemporary** personal style




lisica variations for an **expressive** personal style

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**fabrics**

Lisica Shoulderwear utilizes the breath-ability and stretch qualities of bamboo fabric blends for comfort and fit. Whereas the restricted stretch qualities of hemp fabrics are utilized to support arm weight and to sustain elastic tension within the stability bands replicating the key muscle forces of the shoulder and neck.

**fit and alignment**

The orientation of the rigid hemp fabric to the stretch bamboo fabric provides a simple method for proper alignment of Lisica Shoulderwear. The combination of the rigid and stretch fabrics creates a supportive yet form fitting garment that can be worn externally or as an undergarment.

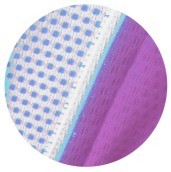
**fastening system**

Lisica Shoulderwear fastens with an oversized button to reduce the need for fine hand dexterity and provides a large surface area for force distribution in the counterbalancing of arm weight between the left and right sides. The oversized bamboo button also provides a design detail that further highlights the use of sustainable materials in this garment.

## design details of the **standard lisica**

**fabrics**

Lisica Shoulderwear utilizes breathable, lightweight fabrics for comfort and fit. Additional non-stretch fabrics are applied to support arm weight and to sustain elastic tension within the stability bands replicating the key muscle forces of the shoulder and neck. The use of technical fabrics helps to wick away perspiration during physical activity.



**fit and comfort**

Lisica Shoulderwear for the athletic lifestyle utilizes 4-way stretch technical fabrics to provide a secure, comfortable, form-fitting garment that can be worn during any physical activity. An additional perforated liner is included to promote greater air circulation and facilitate perspiration evaporation during exercise.

**fastening system**

Lisica Shoulderwear for the active lifestyle fastens with micro-zippers located along rear aspect of the left and right arm segments. This design feature allows arm forces to be transferred seemlessly across both sides of the body while maintaining a secure fit during physical activity. The concealed micro-zippers also create a streamline appearance.

## design details of the **active lisica**

Photos by Laurence Wong.