I, Boya Zhang, hereby submit this original work as part of the requirements for the degree of Master of Design in Design.

It is entitled:
APPLYING METAPHOR ON WEARABLE DEVICE DESIGN

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Applying metaphor on wearable device design

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Abstract

Metaphor began as a kind of the rhetorical methods in traditional linguistics area. But with the deepening of the research in metaphor, metaphor has been applied to diverse disciplines and fields. Metaphor is the imagination connecting the similarities of characteristics and attributes of two different objects. It is also a kind of thinking phenomenon which the characteristics and attributes are mapped from the source area to the target area. Metaphor is a method in which old experiences are used to replace new ones, and it also evokes similar memory, emotion and resonance to the viewer’s when they are using the new product. Metaphor could bring positive impacts to the design. But in addition to literal interpretation of metaphor, there is no clear framework to explain how metaphor is used in the design practice. The purpose of this thesis is to find out a specific representation, which can give designer a clear clue when applying metaphor on their design. Finally this article will propose a framework to describe how to apply metaphor into the wearable device design.

Key words: Metaphor, Wearable Device Design, Anaerobic Exercise
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CHAPTER 1

Introduction: What do we mean by Metaphor

1.1 What does metaphor mean

The English word "metaphor" was derived from the Greek word μεταφορά (metaphorá), which was made of "meta" (means conversion) and “phor” (means transmit). Therefore, the whole word “metaphor” in Greek means the transference of significance. Metaphor began as a kind of rhetorical methods in the traditional linguistics area. It is a figure of speech that connects something as being the same as some unrelated things. Metaphor makes an implicit, implied or hidden comparison between two things or objects that are poles apart from each other but having some characteristics in common.

Traditionally, metaphor was a language rhetoric phenomenon. However, metaphor is not only a linguistic phenomenon, but it also becomes more and more important in a human’s cognitive
phenomenon. Metaphor is the normal way of thinking for human; people's daily conversation is full of metaphors. For example, in this sentence: "the key to the mystery", it does not mean there is a key to open "mystery". However, the sentence implies that the way to unlock the mysteries is as same as the key to open the door. Metaphors play an important role even in the most rigorous scientific language system. In fact, there is an increasing need to use metaphor in abstract philosophy to help people think and cognize. This is because the abstract philosophy language alone is insufficient to help the recognition of human beings. The complexity of human's recognition system makes it difficult to be replaced or represented by a single language system. The other side of the complexity of human's recognition system is that, this complexity makes it is possible for people to create many ways to assist human's recognition. Music, paintings, architectures, interactive and industrial products and so on can all be utilized as metaphors by human's recognition system to understand other objectives. Design is the epitome of what people demands for a thing and an idea. It is a kind of
interaction and communication. Product design not only creates a form or a product, but also expresses a feeling of thinking. Therefore, metaphor is widely applied in design, for example, in the field of architectural design, gothic architecture design represents the medieval religious culture of the mysterious and fanaticism; Baroque architecture embodies the freedom and the wealth of inner thought of the people from 17th century; the popular minimalist style expresses a kind of simple, fast-paced lifestyle of people nowadays. Product design can also be used as a metaphor to help people understand things from the initial idea to the final complex design, followed by the product shapes, colors, lines, materials and processing technology, in which people’s inner thoughts and feelings can all be reflected. Like George Lakoff & Mark Johnson said: the essence of metaphor is understanding and experiencing one kind of thing in terms of another.

1.2 Why do we use metaphor

“The way we think, what we experience, and what we do
As indicated by Lakoff and Johnson, metaphor is closely related to people’s way of thinking. Generally, why people use metaphor can be explained by the following two reasons: the need to in language expression and the cognitive demand.

1.2.1 Expression language

In linguistics, when people cannot find a suitable word in the existing vocabulary to express a particular concept, people will need the help from other areas in an existing vocabulary to understand and express this particular concept, which is a typical metaphor process. For example: Time is money. People use ‘money’, which does not belong to the time domain vocabulary words, to express the preciousness of time and to suggest people to focus on time and cherish it.

1.2.2 Cognitive demand
Cognitive demand of metaphor originated in the earliest human beings whose cognitive abilities are limited. Our ancestors usually mixed two different kinds of things for one thing. With the improvement of human thinking ability, people got to know new things by comparing the differences of things. Therefore, in order to understand and meet a new strange field, people needs to map to a known concept from an unfamiliar area. Metaphor has become an important way and tool that can help human beings get to know new things.

1.3 How metaphor is used in design

“Metaphor conditions our interpretations of the stock market and, through advertising, it surreptitiously infiltrates our purchasing decisions. In the mouths of politicians, metaphor subtly nudges public opinion; in the minds of businesspeople, it spurs creativity and innovation. In science, metaphor is the preferred nomenclature for new theories and new discoveries; in psychology, it is the natural language of human relationships and emotions.”
Here is an example to explain how metaphor works in the field of product design. The product structural features include its performance and appearance. And in the field of music, the music structural features contain of rhythm and melody. Though product and music have different structural features, when people look at a chair with the streamlined shape, the user will feel it like a soothing song. And when people see a sport car, he/she will possibly think of a fast-paced song. Through metaphor, these two different areas are linked together. In other words, metaphor is the mapping experience in the field of the source domain to the target domain, in order to understand the characteristic of the target area (Figure 1-1).

Throughout development, metaphor is not only just a linguistic phenomenon, but it also works as a cognitive model which is a foundation of human communication, cognition, language, thinking and behavior. In the field of design, metaphor has been
widely used in graphic design, architectural design and costume design, especially in product design and interaction design.

![Diagram](image)

Figure 1-1. The relationship among the user, target domain and source domain.

For example, Figure 1-2 shows a CD player from MUJI brand. Its shape lets people first think it is a fan. The switch of the CD player is the "rope" of a fan, and when you pull down the rope, music blows like a wind. Though CD players are in a completely different area to fans, the designer of this CD player put the CD player modeling design into the shape of a fan, through which
these two completely different fields are linked together. In this case, the CD player is the target domain with the feature of melody, and fan is the source domain, which is characterized by wind. When people see the target domain, the source characteristics in the field of "wind" is mapped to the target domain "melody", which makes CD player more vivid and interactive with users.

![Figure 1-2.A CD player from MUJI brand](image)

In interaction design, metaphor is commonly used in software interface design. For example, on the laptop desktop, the recycle
bin icon, folder icon, search icon, and so on are all using metaphor. The function of metaphor for the web interface icon is combined with the concept in the real life. For example, Figure 1-3 shows a video and music player. The sound control icon imitates the real player from the shape, material and the way of use which makes people feel like they are using a physically real player instead of a software.

Figure 1-3. The interface of a video and music player
CHAPTER 2

Applying metaphor on product design

2.1 The relationship between metaphor and product design

As discussed in the first Chapter, metaphor maps source domain feature onto the target domain. When product design is processed, the designers will let the user to understand unknown things through cognition. In this case, metaphor is no longer a rhetorical tool, but as a tool to be used in design. The aim to use metaphor in product is to let designers' emotion to be magnified by their product. In order to attract more customers, each company in the current market are constantly improving their product design by making their products more incisively and vividly. 'Beautiful' products have flooded into the entire design market, and consumers have appeared in the aesthetic fatigue and they are no longer merely satisfied with beautiful appearance, but asking for improved mental experience. In
product design, the application of metaphor is capable of increasing the connotation of the product, let product have interaction and communication with users, make the product more vivid, leaving unlimited imagination to users, and eventually satisfy the needs of users. This process is illustrated in Figure 2-1.

Like the Figure 2-1 shows, when designer design their product through metaphor, they can map users' original experience to a new product, and help users have a good interaction and communication with their new product, in which the comparability
is the link which connects the target domain and source domain. Based on metaphorical way of human thinking, metaphor is a process to associate two different areas of characteristics and attributes, and to let the source domain’s characteristics and attributes map to the target domain (Figure 2-2).

![Diagram of mapping process from source domain to target domain](image)

*Figure 2-2. Illustration of the mapping process from source domain to the target domain.*

### 2.2 Create metaphor in product design

As discussed above, metaphor could bring positive impacts to the design. But in addition to literal interpretation of metaphor, there is no clear framework to explain how metaphor is used in the design practice. The purpose of this chapter is to find out a specific representation, which can give designer a clear clue
when applying metaphor on their design. Finally this article will propose a framework to describe how to apply metaphor into the product design.

2.2.1 Functional attribute and emotional attribute

The attributes of product can be divided into two categories: functional attribute (physical attribute) and emotional attribute (spiritual attribute), in which the functional attribute is stable, rational and denotative, and emotional attribute is unstable, hidden and connoted. Before the creation of metaphor in product design, the attributes of a product (target domain) need to be studied. As shown in Figure 2-3, functional attribute is the physical attribute of the product. It has relatively limited range and refers to function, operation, technology, etc. For example, the functional attributes of a car are steering wheel and horn that could control the direction and the sound, respectively. Emotional attributes represent the culture, interactions and imaginations that are related to the product. It is multi-
dimensional and more extensive attribute compared to physical attribute. When meet with different people in different age, gender, background and life experience, the product will have different spiritual properties. Spiritual properties are established on the basis of people's thinking which reflects the user's emotional interaction with the product. So spiritual attribute can also be named as emotional attribute.

![Diagram showing product attributes with functional and emotional attributes](image)

*Figure 2-3. Target domain attributes analysis*

### 2.2.2 Comparability

As mentioned above, the comparability is the link that connects
the target domain and source domain. Comparability originates from people's thinking activity based on the understanding of attributes of a product. Comparability is formed with imagination, vision, and thinking processes, such as the activities of the association produce. The product comparability is used by designer to express emotions when the product is used to evoke the feeling of being integrated into a certain situation and atmosphere. Product comparability is derived from the following aspects (Figure 2-4).

Transfer of one's old experience to the source domain is based on the understanding of the emotional attributes of a product. Actions indicate the interactive behavior between the users and
the product including use’s operation habit of a specific product. Actions are highly related to the understanding of the functional attribute of a product. At last, circumstances creation is also related to the emotional attributes, which can be inspired by the operation circumstance when using a product. Most comparability is originated visually when people are looking into the attributes of a product. For example, comparability can be made by mapping the shape, color, texture, materials and structure of the target source to the domain source as shown in Figure 2-5.

**Figure 2-5. The characteristics of product comparability.**
The degree of comparability can be classified into three levels including abstract, neutral and descriptive. Figure 2-6 shows the comparison of different metaphoric images (source domains) and the products (target domains) based on the analysis of attributes and comparability. Metaphor was used in design of all these products in which the comparability is applied with different levels.
<table>
<thead>
<tr>
<th>Product Name (Target domain)</th>
<th>Metaphoric Image (Source domain)</th>
<th>Metaphoric Concept</th>
<th>Compare Functional Attribute</th>
<th>Compare Emotional Attribute</th>
<th>Metaphoric Relationship</th>
</tr>
</thead>
<tbody>
<tr>
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<td>✓</td>
<td>✓</td>
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<td>Squirrel</td>
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<td>Tortoise</td>
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<tr>
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<td>Hanger</td>
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<tr>
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<td>Pea</td>
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</table>

Figure 2-6. Comparison of different target domains and source domains based on the analysis of attributes and comparability.
2.2.3 Source domain

The source domain can be found based on the analysis of attributes and comparability of the target domain. The study of source domain is also important because it decides how the mapping from source domain to the target domain can be made. Some features and characteristics of source domain, if mapped to the target domain properly, can make the target domain look more vividly and lively.

In conclusion, metaphor is made by the study of functional attributes and/or emotional attributes of target domain, followed by the study of comparability of target domain and then analysis of the resource domain.

Figure 2-7 shows a flow chart to help a better understanding of the process that how metaphor is created in a product design.

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Before the creation of metaphor in product design, the attributes of a product (target domain) need to be studied in order to find out the comparability. These attributes include but not limited to market positioning, applications, functions of the product and materials that is needed to make the product.

Second, after finding out the attributes of a product, the comparability of these attributes, either functional or emotional, needs to be investigated in order to find out the source domain. The comparability can be made by using designer's experience, and by creating the interactions and circumstances. The designer can judge to what degree (abstract, neutral or descriptive) they want to apply the metaphor.

Finally, the characteristic of source domain will also be analyzed to find out identic features that can be used to map to the target domain. The purpose is to let users accurately identify when they see the target domain, and converting the extracted attributes from source domain to the specific design.
Figure 2-7. A flow chart that explains how metaphor is created during the product design.

The next part of the thesis will embody the as mentioned theory into a real product design - a wearable device for anaerobic
exercise. Wearable devices have attracted extensive attentions in recent years due to their convenience and effectiveness in collecting and analyzing physiological data during exercise. However, there are less wearable devices for anaerobic exercise like weight lifting compared to the diverse wearable devices for aerobic exercise like running. According to the survey, current wearable devices, especially wearable sport devices, don’t have a good communication with users during operating. By using metaphor method, this design aims to improve the communication between devices and users during operation. As will be introduced in Chapter 3, the metaphor design will make wearable sport devices user-friendly and lively.
CHAPTER 3

Applying metaphor on wearable device

3.1 Wearable device background

With the release of Google glass in April 2012, the wearable device has become a hot topic on the market. Wearable device is a terminal equipment, which could be continuously worn by the human. It has the advanced circuit, wireless networking and independent processing capacity. So far, there are different kinds of wearable devices on the market, which can fall into the following classifications based on their functional attributes.

3.1.1 The variety of wearable devices

The wearable devices in the market can be classified into the following categories based on their functions.

a. Sports & Fitness
With the development of wearable devices, sports tracking performance is more and more emphasized as long as the functional requirements of convenient social media sharing. It is also important for athletes and exercisers to get qualified feedback about sport data during workouts. The key of wearable technologies is to make data collecting in a convenient and efficient way. Nowadays, heart rate monitors, GPS watches and pedometers are already widely used in sports and fitness wearable devices.

b. Healthcare & Wellness

With the aging of population, geriatric disease as long as the medical cost has increased rapidly. Through healthcare devices, people can collect the health information by themselves thus avoiding unnecessary visits to the doctors and save the health expense. The healthcare industry will have a huge potential in the next few decades resulting in endless opportunities for new technology solutions. Wearable devices have the potential to
give patients more independence and in some cases, the freedom to stay home instead healthcare center.

c. Security & Prevention

Wearable technology can also play an important role in the area of safety and security. Many types of sensors including gas sensor and chemical sensor can be implanted into wearable devices to highest safety and security standards.

d. Gaming & Lifestyle

The world of gaming has been undergoing massive changes. The game platforms are becoming as unobtrusive as possible in which the wearable devices can largely benefit this process. Therefore, wearable devices are the key to a smooth process, novel and interesting experience.
3.2 Analysis wearable sports device for anaerobic exercise

As discussed above, there are a lot of different wearable devices on the market. Among the wearable sports devices, aerobic exercise equipments such as Nike Fuelband, Jawbone Up, GlassUp and Fitbit Flex domain the market. Devices technology in aerobic field is increasingly mature. However, the products for the area of anaerobic exercise are immature with limited products available. Exercisers who prefer to do anaerobic exercise are lack of feedback and information from reliable wearable devices. Here in this thesis, a wearable sports device for anaerobic exercise will be presented. The product design follows the theory mentioned in Chapter 2 with the application of metaphor. As will be presented next, several case studies have been done before the product design.

3.2.1 Available anaerobic wearable devices on the market

Case 1: OMsignal biometric smartwear
Figure 3-1. OMsignal biometric smartwear.

As shown in Figure 3-1, the OM compression shirt is for those who want to take their training from the treadmill to the streets. The built-in smartphone pocket is great for training outside the gym. Performance-grade compression increases blood-flow, delivering more oxygen to muscles, enhancing both performance levels and post-workout recovery (www.omsignal.com).

Case 2: Hexoskin smart shirt
As shown in Figure 3-2, The Hexoskin smart shirt is an advanced biometric shirt on the market. It measures many body metrics with great precision (www.hexoskin.com).

**Case 3:** Athos smart compression shirts
As shown in Figure 3-3, Athos makes smart compression shirts for men and women, shorts for men, and capri-style pants for women that are the next wave of performance apparel. They measure a variety of data about heart, lungs, and muscles as people work out, counting the sets and reps, and showing in real time how hard muscles are working.

**3.2.2 Analysis of case study**

All these cases as shown above use cloth as anaerobic devices with a lot of sensor in imbedded to collect health date during
workout. As illustrated in Figure 3-4, the collected data and information can be analyzed by central processing unit and then share the data and information with other smart devices such as smartphone through Bluetooth.

![Figure 3-4. Illustration of how cloth-like anaerobic devices work.](image)

The advantage of these cases lies in the convenience of the cloth like design, which can physically protect the exercisers. The well-implanted sensors can also provide an accurate and effective way to collect health data and information. However, it is impossible for exercisers to know the information that is collected by these products simultaneously during their workout,
since there is no visual interaction between these smart cloths and users.

In order to improve the performance of these wearable devices, I went to the gym and made a survey test for 15 peoples. The survey format is shown in Figure 3-5.
Survey of wearable sport device for anaerobic exercise

1. What is your age?
   a. <18-20  b. 21-25  c. 26-30  d. 31-35  e. 36-40  f. 41-49  g. 50-59  h. 60+

2. What is your gender?
   a. Male   b. Female

3. How many times will you use the gym equipment in a week?
   a. <3  b. 3 – 4  c. 5-6  d. everyday

4. When working with gym equipment, do you meet some problem?
   (You can choose more than one)
   a. Need to recording data from machine
   b. Don’t have a guide
   c. Don’t have a specific planning
   d. Want to know muscle Effort
   e. Want to understand the state of muscle when have an action
   f. Want to know muscle fatigue
   g. Want to know Heart Rate
   h. Want to know breathing patterns

5. Based on your experience, Please sort the option from most important to general about wearable device:

   a. Usability :  
   b. Ease of use :  
   c. Wearability :  
   d. Requests :  
   e. Aesthetic :  
   f. Connection :  
   g. System Consistency :  
   h. Visibility :  
   i. Navigation :  
   j. Capability Enhancement :
Fifteen people including eleven males and four females have taken the survey, with 7 people between the age of 21 to 25, 6 people between the age of 26 to 30, and 2 people between the age of 31 to 35. The most of them have plans to go to gym 3 to 4 days per week. Based on the feedback, people would like to
know how to use their muscles in a right way during a set of actions, especially for those people who just begin their anaerobic exercise. They hope this sports device is capable to give them information by itself without the assistance of an app from the smart phone. They would like to get the feedback from the wearable devices immediately during their workout, through which they can make adjustment and corrections up-to-the-minute to avoid possible injury and accident during workout. Therefore, a screen design in these wearable devices looks like very necessary because it can provide a simultaneous feedback to the users.

3.3 Application of metaphor on the wearable device design.

Based on the case study and the feedback from the survey, I designed a smart cloth for anaerobic exercise following the flow chart as shown in Figure 3-6, in which the theory in Chapter 2 of applying metaphor into product design was used.
Wearable sports device for anaerobic exercise.

**Metaphoric Classification**

*Functional*
- Need a guidance to guide user let them use the right muscle. Assure security issue.
- Need a screen on the cloth not just a APP that can check out the feedback at the same time when doing the action.

*Emotional*
- Let sports device does not just a cloth but also have more interaction and communication with user.

**Comparability**
- Create circumstances

**Chameleon**

**Mapping**
- Form
- Structure
- Color
- Name
- Material
- Interaction
- Texture
- Graphic
- Sound
- Taste
- Touch
As shown in Figure 3-6, the new wearable sports device is designed for anaerobic exercise. There are two types of attributes - functional attributes and emotional attributes to study. For the functional attributes, the new product needs a guidance to advise user to use the right muscle during anaerobic exercise. The functional part also includes a screen on the cloth for the user to check their health information simultaneously during their workout. For the emotional part, users would like to have an interaction and communication with sports device. They would also like the sports device more lively and playful. With all these analysis of attributes, comparability was made between this wearable device and chameleon that can change the color of their body in some certain circumstances for self-defend. Then I use the feature "color" in the source domain (chameleon in this case) to do the mapping back to the target domain (wearable sports device in this case). The change of the color on the
wearable sports devices can work as a reminder to let user understand the right way of using their muscles in a set of action.

3.4 Design of the proposed wearable devices

3.4.1 Introduction the design concepts

The wearable sport device has three parts including tops, pant and smart bracelet. In the tops and pant, there are several sensors that can test the force applied on muscles. The sensors on the smart bracelet are capable to indicate the misbehaviors during workout by showing lights with different colors. The name of this wearable device is ‘Lively Muscle’.

There are three different concepts of design for this wearable device, as shown in Figure 3-7, Figure 3-8 and Figure 3-9.

The Figure 3-7 is the first concept for this design. The design style is a pilot lamp with different colorful dot. When you choose
a set of action on your smart bracelet, the screen will give you a guide to tell you which area of muscle you should use. If you use the wrong area of muscle, the cloth will show the red dots on the pilot lamp. And if you use the right area of muscle, the cloth will show the blue dots on the pilot lamp. If you ignore an area of muscle that you should use for a certain action, the smart cloth will show the yellow dots on the pilot lamp.

*Figure 3-7. Concept 1 of the smart cloth.*
Figure 3-8 shows the second concept for this design. The design style is a pilot lamp with different colorful area. When you choose a set of action on your smart bracelet, the screen will give you a guide to tell you which area of muscle you should use. If you use the wrong area of muscle, the cloth will show the red light in area on the pilot lamp. And if you use the right area of muscle, the cloth will show the blue light in area on the pilot lamp. If you ignore an area of muscle that you should use for a certain action, the smart cloth will show the yellow light in area on the pilot lamp.
Figure 3-9 shows the third concept for this design. The third design style is a pilot lamp with different colorful lines. When you choose a set of actions on your smart bracelet, the screen will give you a guide to tell you which area of muscle you should use. If you use the wrong area of muscle, the cloth will show the red flowing line on the pilot lamp. And if you use the right area of muscle, the cloth will show the blue flowing line on the pilot lamp. If you ignore an area of muscle that you should use for a certain
action, the smart cloth will show the yellow flowing line on the pilot lamp.

Figure 3-9. Concept 3 of the smart cloth.

Besides the smart cloth, I also designed three different concepts bracelets that are compatible to the smart cloth. The smart bracelet is the center of the system collecting the body information from sensors, so that you can use your bracelet to get the feedback from your body. It can also send health data...
and information to your mobile device through Bluetooth. The bracelet also works as the screen to show the health information during workout and can be fixed on the arm through the magnetic attachment.

Figure 3-10 shows the concept 1 for bracelet with a flat surface of the screen.

Figure 3-10. Concept 1 of smart bracelet design.
Figure 3-11 shows the concept 2 for bracelet. The second design style is a semicircle bracelet with a screen that the image of data can be shifted down when you rotate your arm. So the screen can automatically adjust based on your body movement.

![Figure 3-11. Concept 2 of smart bracelet design.](image)

Figure 3-12 is the concept 3 for bracelet. The third design style is a semicircle bracelet with a triangular design in which the image of data can be shown on two half screen independently.
3.4.2 Survey for the design concepts

In order to better understand the users preferences, I made surveys for both the three concepts for smart cloth design and smart bracelet design, as will be shown in Figure 3-13.
The Survey test of wearable device design

Gender: 
Age: 15 - 20 21 - 25 26 - 30 31 - 35 36 - 40 41 - 45 46 - 50 51 - 60

This wearable sport device is designed for anaerobic exercise. Wearable devices have attracted extensive attentions in recent years due to their convenience and effectiveness in collecting and analyzing physiological data during exercise. However, there are less wearable devices for anaerobic exercise like weight lifting compared to the diverse wearable devices for aerobic exercise like running. According to the survey, current wearable devices, especially wearable sport devices, don't have a good communication with users during operating. By using metaphor method, this design aims to improve the communication between devices and users during operation. The metaphor design makes wearable sport devices user-friendly and lively. This design is inspired by animals that can switch the body color when they are feeling environmental changes. The sport device has three parts including tops, pant and smart bracelet. In the tops and pant, there are several sensors that can test the force applied on muscles. The sensors on the smart bracelet are capable to indicate the misbehaviors during workout by showing lights with different colors. The name of this wearable device is 'Lively Muscle'.

According to the picture, which bracelet do you like best?
A. Option A.  B. Option B.  C. Option C.

According to the picture, which cloth do you like best?
A. Option A.  B. Option B.  C. Option C.

Do you have any suggestion for the 'Lively muscle'? Please give a brief explanation.
Test of Smart bracelet

Option_A

Scene Graph

This is a smart bracelet of ‘Lively Muscle’. The first design style is a short bracelet with a mini screen. It can stick firmly on cloth through the magnetic attachment. The smart bracelet is the center of the system collecting the body information from sensors, so that you can use your bracelet to get the feedback from your body. It can also send information to your mobile device through Bluetooth.
Test of Smart bracelet

Option_B

Scene Graph
This is a smart bracelet named ‘Lively Muscle’. The second design style is a semicircle bracelet with a screen one which the inside data can be shifted down when you rotate your arm. So the screen can automatically adjust based on your body movement. It can stick firmly on cloth through the magnetic attachment. The smart bracelet is the center of the system collecting the body information from sensors, so that you can use your bracelet to get the feedback from your body. It can also send information to your mobile device through Bluetooth.

Scene Graph
Test of Smart bracelet

Option_C

Scene Graph

This is a smart bracelet named ‘Lively Muscle’. The third design style is a semicircle bracelet with a screen one which the inside data can be shifted down when you rotate your arm. So the screen can automatically adjust based on your body movement. It can stick firmly on cloth through the magnetic attachment. The smart bracelet is the center of the system collecting the body information from sensors, so that you can use your bracelet to get the feedback from your body. It can also send information to your mobile device through bluetooth.
Test of Smart Cloth

Option_A

This is a smart cloth. The design style is a pilot lamp with different color dot. When you choose a set of action on your smart bracelet, the screen will give you a guide to tell you which area of muscle should you use. If you use the wrong area of muscle the cloth will show the red pilot lamp based on that area of muscle, if you use the right area of muscle in this action it will show the blue pilot lamp, if you ignore an area of muscle which you should use it will show the yellow pilot lamp.
Test of Smart Cloth

Option_B

This is a smart cloth. The design style is a pilot lamp with different color area. When you choose a set of action on your smart bracelet, the screen will give you a guide to tell you which area of muscle should you use. If you use the wrong area of muscle the cloth will show the red color in that area, if you use the right area of muscle in this action it will show the blue color, if you ignore an area of muscle which you should use it will show the yellow color.
This is a smart cloth. The third design style is a pilot lamp with different color line. When you choose a set of action on your smart bracelet, the screen will give you a guide to tell you which area of muscle should you use. If you use the wrong area of muscle it will show the red line, if you use the right area of muscle in this action it will show the blue line in that area, if you ignore an area of muscle which you should use it will show the yellow line.

Figure 3-13 Survey test for 3 concepts for both smart cloth and smart bracelet.
I collected feedbacks from fifteen people made of eleven males and four females. For the smart cloth, people prefer the option C most, in which a flowing line is used to make interactions. For the smart bracelet, most of people choose the second design concept, which has a ring-like shape. However, according to the feedback, some people think the bracelet cannot be very fixable when doing exercise. Some of them suggested having a band design with bracelet. After analysis all feedbacks, I redesign the bracelet as Figure 3-14.

3.4.3 Redesign of the bracelet

Figure 3-14 and 3-15 shows the redesign of the smart bracelet. Different than the old version, a rubber band is used in the new bracelet design in order to provide more flexibility and compatibility of the bracelet. Users can easily take off the smart bracelet by pushing the button as shown in Figure 3-15. Figure 3-16 shows the different color options for the redesigned smart bracelets.
Figure 3-14 New bracelet design
Figure 3-15. Configuration of the redesigned smart bracelet.

Figure 3-16. Different colors of the redesigned smart bracelet.
3.5 Conclusions

Metaphor has been widely used in the linguistic system as well as the product design. Application of metaphor in product design can make the product lively and vivid. This thesis proposes a theory that can help designer to apply metaphor into their product design in a smooth and effective way. This theory has been used in an anaerobic wearable device design as presented in this thesis. The anaerobic wearable device presented in this thesis is a multifunctional wearable device with improved convenience to the users and enhanced interactions with the users. Several surveys were done in order to complete the theory study and product design. This wearable device is highly valued by people who took the survey and the feedbacks from these surveys were applied to redesign the product. The success of this product design proves the feasibility of the proposed theory, which shows great potential to help designer improve their design.

Zoltán Kövecses, Metaphor in Culture: Universality and Variation


Donald A. Norman, Emotional Design: Why We Love (or Hate) Everyday Things
A Tree as a Metaphor for Cultural Systems

http://leadershipparadigms.com/blog/2011/02/09/a-tree-as-a-metaphor-for-cultural-systems/

Athos – Wearable Technology for fitness

http://www.liveathos.com/

Mark Billinghurst, Wearable Devices New Ways to Manage Information,
University of Washington