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ICT-BASED ON HEALTH CARE SOLUTION FOR SUB HEALTH PEOPLE

IKT PÕHINE TERVISHOIULAHENDUS STRESSIST TINGITUD HAIGUSTE ENNETAMISEKS

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Master's Thesis Task

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Master's Thesis topic:

ICT-based on Health Care Solution for Sub Health People

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Tasks and timeframe for their completion:

NR	TASK DESCRIPTION	COMPLETION DATE
1	To define problem of sub health status through research and to find the opportunity in health care field that would increase the market share of JOINTECH	01.03.2014
2	To figure out a clinical solution for the defined problem	20.03.2014
3	To figure out an ICT-based on concept and do experiments to test how the concept works	20.04.2014
4	To develop the ICT-based on concept into a conceptual product with design methods	20.05.2014

Design and Engineering problems to be solved:

Main objective of this thesis is to give health care solution to target group people who are in 30-40 years age and live stressed.

This solution is going to be a conceptual product, which is based on ICT technology, and works between the smart phone and a wearable accessory to monitor wearer's physical condition, collect data, give warning and guide them to increase their health level. Furthermore, an individual health care service could be broadened to link with a health care platform from JOINTECH, which could help target group people to take care better themselves and try to get away from potential disease before they step to middle-aged period.

Defense application submitted to deanery not later than 14/5/2014

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Abstract

JOINTECH is a company that is engaged in electronic product development. Product design background makes it competitive in innovation and technology integration. As a new sequence, health care product is becoming the main focus and an increasing point in their business development. In 2013, a health care service platform with a central database and linked with medical institutions was built, based on which health care service is provided for specific target people. By the year of 2014 spring, a product and a sequence service for elderly have released. Currently, they are seeking out fresh idea in this field.

From the news, we know what is happening in industrial countries, the number of workers aged 30 even younger who have died suddenly on the way home is increasing. More individuals of this age group are showing early symptoms of some chronic diseases such as diabetes and coronary heart disease that should happen in their 50's as before. The frequent occurrence of similar incidents moves our focus to a hot topic---sub health. Sub health is not a sort of disease but it affects our health and everyday life. The increasing attention to health care-related research regardless of medical industry, technical industry or social science and so on, various solutions are designed for vulnerable groups such as elderly, children and disorders Etc. However, solutions for sub healthy people are usually neglected. Instead, from this point of view, these majorities become the vulnerable ones. Both above facts indicate that sub health is a growing issue and this peaked my interest leading me to make it my thesis topic. In terms of market value for a company, as there are not many solutions and products in the market thus creating an opportunity in this field.

The aim of this project is to define a main problem that sub-health people have and to learn an effective clinical solution for this problem. Most importantly this project will aim to create a new experience with design approaches to help sub-health people decrease disease risks in the future.

The structure of this master thesis is a description about the whole developing process. Start from a health care topic and define problems then develop solution and conceptual product. Following the Double Diamond design process, all 10 chapters can be divided into two main parts. Chapter1 Introduction makes boundaries of this project. Chapter2 and chapter3 focus on problem definition. After Pre study and Research on sub health term, the target problem about sub health status is defined as: *People need to know that they are in disease risk because of high stress, and learn to relieve stress in a right way anytime and anywhere when they are stressed to get inside balance.* As a health care related project, the solution for the target problem must be professional and effective. In this thesis, many studies on an effective clinical solution are described in chapter4. All above chapters can be the first part of this thesis, which focus more on health care involved issues. However, the purpose of this project is not only figuring out a clinical solution for potential users but also improve it through design. Design is an important tool in industry. It usually plays a role to link the different fields. The second part of this thesis includes studies in developing this clinical solution into a conceptual product. Between clinical solution and conceptual product, experiment in chapter5 and market analysis in chapter6 can be a connection in this thesis. Experiments and analyses give out further target problems and future opportunities. In chapter7 studies on technology system, user interface, ergonomics, esthetics and model test are around a main task: *To design a HRV biofeedback-based on product that can lift mood of stressed people through a pleasant user experience.* Lastly, in the delivery chapter8, a new experience of stress management is described through the user scenario. The conceptual product could provide a new experience to users and the experience could link each separate part in this increasingly complicated interaction. Furthermore, as a company-background project, more developing work is going to do on production feasibility, market evaluation and working sample testing in JOINTECH Company in the future. These are mentioned in the chapter10.

Contents

Abbreviations

1. Introduction

- 1.1 Company 9
- 1.2 Project Background 9
- 1.3 Aim 10
- 1.4 Deliverables 10
- 1.5 Delimitations 10
- 1.6 Methodology 11

2. Pre study

- 2.1 Sub Health Definition 12
- 2.2 Sub Health Diagnosis 12
- 2.3 Problems of Sub Health 13
- 2.4 Conclusion 13

3. Research

- 3.1 Method 14
- 3.2 Sub Health & Health Care 14
 - 3.2.1 Target Group Definition 15
 - 3.2.2 Target Group Interview & Their Life 15
 - 3.2.3 Meet Experts 17
 - 3.2.4 GIGA Map on Sub Health State 18
 - 3.2.5 Conclusion 19
- 3.3 Stress & Stress Management 20
 - 3.3.1 Stress 20
 - 3.3.2 Stress Management 21
 - 3.3.3 Stress Management System 21
- 3.4 Target Problem Definition 22

4. Clinical Solution Development

- 4.1 Method 23
- 4.2 Present 23
- 4.3 Stress & Biofeedback 24
 - 4.3.1 Stress & Physiological Response 24
 - 4.3.2 Physiological Response & Biofeedback 25
 - 4.3.3 Biofeedback Solution Analysis 26

4.4	Clinical Solution of Stress Management	27
4.4.1	HRV	27
4.4.2	Stress & HRV	28
4.4.3	HRV Index	29
4.4.4	Breathing & ANS	30
4.4.5	Breathing Work Principle	31
4.4.6	Conscious Breathing	31
4.4.7	Abdominal Breathing Technique	32
4.5	Conclusion	33

5. Solution Experiment

5.1	Method	34
5.2	Experiment Purpose	34
5.3	Figures From Experiment	35
5.4	Problems of User Experience	36
5.4.1	User Journey Map	37
5.5	Conclusion	38

6. Market Analysis

6.1	Method	39
6.2	Product Life Cycle	39
6.3	S.W.O.T Analysis	40
6.4	Product Positioning	40
6.5	Product Strategy	42

7. Product Development

7.1	Method	43
7.2	Technology System	44
7.2.1	Tracking System	44
7.2.2	Training System	45
7.2.3	Functional Structure	46
7.2.4	Morphological Matrix	46
7.2.5	Engineering Concept Evaluation	47
7.3	User Interface	47
7.3.1	Users' Pain	47
7.3.2	Dandelion Story	48
7.3.3	Communication Links	49
7.4	Ergonomics	50
7.4.1	Sensitive Area on Wrist	50
7.4.2	Section of Inner Diameter	51
7.4.3	Bracelet Structure Test	51

- 7.5 Esthetics 53
 - 7.5.1 Identity of “White-Collar” 53
 - 7.5.2 Mood board 53
 - 7.5.3 Visualization 54
- 7.6 Model test 57
- 7.7 Concept Re-evaluation 58
 - 7.7.1 Concept 58
 - 7.7.2 Concept Re-evaluation 59
- 7.8 Band Concept Development 59
 - 7.8.1 Leather Belt Structure (Ergonomics) 59
 - 7.8.2 Mood Board (Esthetics) 60
 - 7.8.3 Color (Esthetics) 60
 - 7.8.4 Graph (Esthetics) 60
- 7.9 Conclusion 61

8. Delivery

- 8.1 Method 62
- 8.2 Product Appearance 62
- 8.3 Usage 63
- 8.4 App & Scenario 64
 - 8.4.1 APP 64
 - 8.4.2 Scenario 65
- 8.5 Engineering 66
 - 8.5.1 Cover Parts 67
 - 8.5.2 PCB Layout 67
 - 8.5.3 Principle of Fragrance Device 68
- 8.6 Materials 69

9. Future Development 70

10. Conclusion 71

List of Figures 71

References

Abbreviations

ANS	Autonomic Nervous System
SNS	Sympathetic
PNS	Parasympathetic
SA	Sinoatrial
AV	Atrioventricular
HR	Heart Rhythm
EEG	Electroencephalography
ECG	Electrocardiography
HRV	Heart Rate Variability
IBI	Interbeat interval
R-R	Rate-Rate
MEAN	R-R interval in a period
LF	Low Frequency
HF	High frequency
APP	Appication

1. Introduction

This project covers a master thesis in product design for the program Design & Engineering at Tallinn University of Technology conducted in autumn 2011 - spring 2013. It develops under the background of a Chinese technology company named JOINTECH. The focus is on a conceptual product feasible and valuable for market in health care field in which ICT should be a core technology.

1.1 Company

JOINTECH is a company that is engaged in electronic product development. Product design background makes it competitive in innovation and technology integration. As a new sequence, health care product is becoming the main focus and an increasing point in their business development. In 2013, a health care service platform with a central database and linked with medical institutions was built, based on which health care service is provided for specific target people. By the year of 2014 spring, a product and a sequence service for elderly have released. Currently, they are seeking out fresh idea in this field.

The following chart shows the work principle of JOINTECH health care service platform.

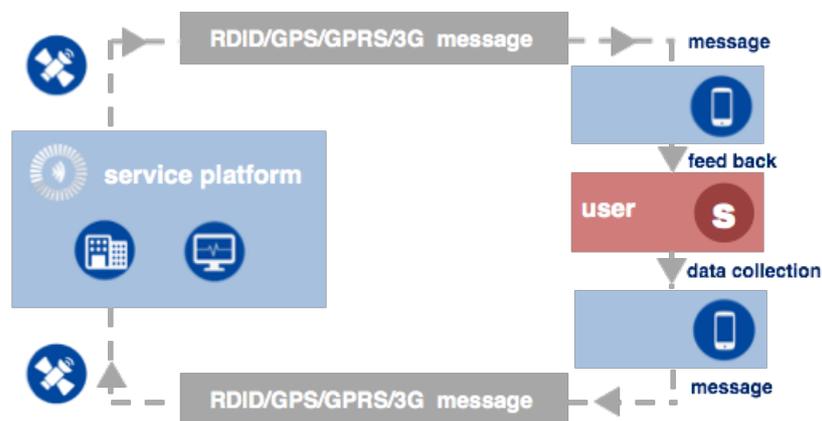


Figure1.1 JOINTECH Health Care Service Platform

The core technology of this platform---3G or 4G telecommunication technology links a large-storage server with smartphone and some wearable devices based on wireless transmission protocol such as Bluetooth, WIFI and Zgbee Etc. to build a communication cycle between internet, mobile devices and users. This cycle is able to provide health care services like danger warning, remote consulting, clinic information, medical assistant and so on.

In this project, focus is more on the sub cycle that works between users, smart phone and wearable devices.

1.2 Project Background

From the news, we know what is happening in industrial countries, the number of workers aged 30 even younger who have died suddenly on the way home is increasing. More individuals of this age group are showing early symptoms of some chronic diseases such as diabetes and coronary heart disease that should happen in their 50's as before. The frequent occurrence of similar incidents moves our focus to a hot topic---sub health.

Sub health is not a sort of disease but it affects our health and everyday life. The increasing attention to health care-related research regardless of medical industry, technical industry or social science and so on, various solutions are designed for vulnerable groups such as elderly, children and disorders Etc. However, solutions for sub healthy people are usually neglected.

Instead, from this point of view, these majorities become the vulnerable ones. Both above facts indicate that sub health is a growing issue and this peaked my interest leading me to make it my thesis topic. In terms of market value for a company, as there are not many solutions and products in the market thus creating an opportunity in this field.

1.3 Aim

Based on the JOINTECH health care platform, aim of this project is to figure out a conceptual product that has the ability to solve the main problem of sub health status. The users are able to experience a clinical treatment in a pleasant way.

ICT based on solution is usually high technology-integrated. Another aim of this project is going to understand further about how an ICT based on solution works well between separate objects, how to play the strengths of each technology, which is the sticking point in the product solution within the internet environment.

Furthermore, as wearable technology is becoming a possibility and one of the main product forms in the future, it requires that designers are capable to use design methods to address interdisciplinary problems. This project is going to use my own experience and opinion on this practice in wearable design.

1.4 Deliverables

In order to get a feasible and effective solution, research in medical field about sub health, ICT technical principle and user experience are the most important parts in this project. Feasibility and value are highlighted here as the criteria in the evaluation of project result, in which the interpretation of value goes to the market value for company and experience value for users. The final outcome of this project in feasibility goes to a conceptual product including medical strategy, ICT process, and industrial concept design. More work in detail on production is going to be carried out in the future development by JOINTECH Company.

The following is a list of the sub-deliverables in this project.

1. Understanding of the sub health status in clinical level.
2. Target sub health problem that people mostly suffer from.
3. Relations between the target problem and ICT strategy.
4. Analysis of the current market for potential opportunities.
5. A clinical solution to solve the target problem.
6. Technology principles and working processes.
7. Experiments for determining feasibility and effectiveness of the solution.
8. Analysis of user requirements to a wearable product in esthetics, ergonomics and user experience to create a pleasant experience.
9. Analysis of wearable-related issues in design field.
10. Visualization on product appearance in sketch, 2D rendering, 3D modeling and mock-up.
11. Personal experience and opinions on ICT based on wearable product design.

1.5 Delimitations

All the work needed for realization on this concept cannot be covered in this project due to the limitations of given resources. So as to understand this project better, delimitations are mentioned in following. Uncovered issues in the future development can be found in the Chapter 9 of this thesis.

1. In terms of market range, this project is based on global market and particularly industrial countries. However, there are differences in health care systems in different nations, and only the sub system that runs between smartphone and wearable devices stands globally. This thesis only works in Chinese health care system.
2. The estimate of cost related to manufacturing will not to be taken into account.
3. In order to complete the concept, electronic components suggested here are only user interface related, for instance small size sensor, high efficient chip and proper size battery and

so on.

4. No software code or simulation in this project. Any Application running in smart phone will only include graphic user interface screen.

5. No working sample can provide experiment on the conceptual product. Experiments on the clinical solution are in JOINTECH through a similar product. Further tests for how the concept works on target people will be in JOINTECH Company as a future development.

1.6 Methodology

The working process in this project follows the Double Diamond Model that is developed by The Design Council in United Kingdom, in which general design activities are illustrated in a diamond-like model.

“Divided into four phases: Discover, Define, Develop and Deliver, it maps how the design process passes from points where thinking and possibilities are as broad as possible to situations where they are deliberately narrowed down and focused on distinct objectives”. (Design Council 2005)

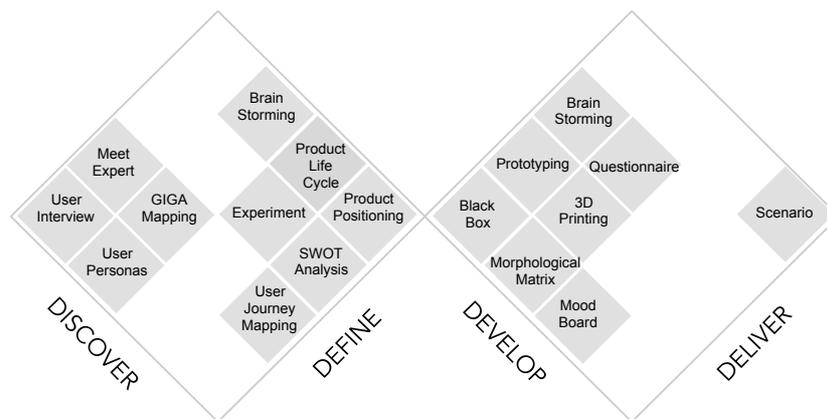


Figure 1.2 "Double Diamond" Model

The whole process of this project can be illustrated in this model. In addition, more approaches that are usually used in design and marketing analysis are also adopted in each phase according to different sub purposes, for example GIGA mapping for general analysis and relation exploration, User journey mapping for user experience and S.W.O.T analysis for marketing strategy Etc. These tools supply an initial idea step by step, which is a valuable experience to me. More description in detail about how to use each tool will be explained in each phase.

2. Pre Study

At the beginning of this project, many questions come to my mind: What is sub health exactly? How to diagnose whether a person is in sub health or not? What is the cause of this physical status? In order to get correct answers and acquire a deeper understanding about it at the clinical level, a previous study in sub health professionally is necessary. During that period after reading many articles, communicating with experts and target users, all above make the target problem increasingly clear. To sum up, purpose of this chapter is to define a target problem of sub health status.

2.1 Sub Health Definition

Sub health, known as the “third health condition” or “grey state”, is a borderline state between being healthy and falling sick. In this critical state, people are not sick, but they do not feel well. The immune system is weak making people more susceptible to falling ill. Actually, it has no precise definition but is generally defined as low physical activity and adaptability regularly occur.

Most of us have had this experience: Feeling under the weather, but the doctor is unable to find anything particularly wrong with us when we go to the clinic after doing a sequence check up. If so, we could be having a sub-health condition which shows up in symptoms such as chronic fatigue, poor appetite and general body weakness.

Compared to the definition of health: “Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (World Health Organization 2003), the definition of sub health can be simplified as a status between health and disease.

2.2 Sub Health Diagnosis

Because sub health is not defined as a disease, there are different ways to diagnose sub health. For example, medical technology is able to give body information enabling people to know themselves at the genetic level. People are able to know if they will be at risk in the following decade. However, it is still a cutting-edge technology without popularization, and it is very expensive to check up. The conventional medical check up shows people several physical indicators such as blood pressure, blood sugar and cholesterol Etc. It is a common way for people to get their health information from this one year routine check up.

Normally, people are able to determine whether they are in sub health status or not from some typical symptoms: indigestion, back pain, low mood, sleep disorders and frequent colds. In many medical institutions, this self-report is identified as an effective diagnosis on sub health status. The most popular measurement standard is according to Fukuda complete text of revised case definition in American control disease center (CDC) in 1994 (*Chinese Medicine, 2010, 1, 39-42*)

Sub health symptoms are divided into two groups, namely physical health-related sub health symptoms and mental health-related symptoms for the purpose of accurate diagnosis. Total nine items are tested in diagnosis on sub health. People should answer each item as yes or no. If the answer is yes, one score will be added (except the Chronic Fatigue). Two score will be added for the Chronic Fatigue, because it is the most typical symptom of sub health status. The Chronic Fatigue means clinically that the profound fatigue is not improved by bed rest and may be worsened by physical or mental activity. After all the items are finished, the person whose score more than six is considered as in sub health status.

Physical health-related symptoms	Mental health-related symptoms
-Chronic fatigue -Indigestion -Muscle soreness -Frequent colds -Lymph tenderness	-Sleep disorders -Difficulty concentrating -Impaired short-term memory -Dizziness and headache

Figure 2.1 Fukuda complete text of revised case definition (CDC) in 1994

2.3 Problems of Sub Health

Sub health is becoming a serious problem in health care field. A lot of countries make it as a key point to improve the physical fitness of their population. From a different point of view, people can understand the importance of solving this problem.

Firstly, it has been reported from WHO that more than 70 percent of people in the world are in sub health status (*Chinese Medicine, 2010, 1, 39-42*). In some labor-intensive industrial countries like China, there are more sub-healthy people. Figures from an investigation done in Hong Kong showed that the vast majority (97%) of the respondents reported having experienced at least three sub health symptoms (<http://hkupop.hku.hk>). The results of a clinical research indicates that people with sub health problems could become severely ill later in their life, and this is highly correlated with their sub health problems (*Chinese Medicine, 2010, 1, 39-42*). For instance, a patient who is suffering from diabetes usually has had endocrine imbalance for several years. He/she has been experiencing sleepiness and hair loss before diabetes symptoms appears. Secondly, even though sub health does not equal to chronic diseases, it has a serious impact on our life quality and work performance. The same investigation conducted in Hong Kong indicated that nearly two thirds (64%) of the respondents complained that sub-health symptoms are affecting their daily life. A majority of them thought sub-health symptoms affected their work performance, and left them listless with no spirit or energy, as well as affecting their family and social life. Thirdly, in some cases, long-term mental sub-health suffering such as depression may lead to extreme incidents such as suicide. Studies show that the most common disorders among people who die by suicide are major depression and other mood disorders (*Bertolote & Fleischmann, 2002*). To sum up, in a sense sub health is more dangerous than disease. Ask you self a common sense question: What is more dangerous, when you know the enemy or when you do not know? "Sub health is different from illness. A person appears perfectly normal to others, because of which he/she may not be aware of their vulnerable health conditions, and thus at a greater risk of developing a chronic disease. The impact of sub health should not be underestimated." (*Doctor Chen-consultant*)

Another focused problem about sub health much relates to the aim of this project: How to pay more attention to sub-healthy people? What service can be provided to make them better? Currently, health care system in most countries consists of two main sub structures: medical treatment and regular health check up. The latter one is the main way for people to understand their health condition. Unfortunately, people can get nothing useful if each indicator in the check up report is normal. Most of them work for people who already have symptoms of diseases. In reality, in terms of some heavy chronic diseases, it is too late and dangerous. Obviously, sub health problem cannot be covered in current medical system.

2.4 Conclusion

Sub health is a state between complete health and disease. It is usually diagnosed through a self-report. Problems of sub health impact people's work and life seriously. They are easy to ignore because they are not covered by current health care system in most countries. It is an invisible danger in our life.

3. Research

Through the pre study phase, a complex problem related medical science, social science, psychology and technology appears. Sub health covers a wide range, which needs to be narrowed and a concrete problem targeted.

3.1 Method



Figure 3.1 Methods in Research

The discovering process is carried out by some methods. After defining the target user, the first step is an interview as this is a direct way to collect information from target users. Six persons from different regions gave their answers on some designed questions and shared their stories about health care issue in their lives. With this information, the method of “User Personas” helps to shape features of this target group people and helps to understand their lives and the sub health problems they face. Second step was talking to experts about medical issues. Finally, GIGA map is adopted as the main research tool arranging all information from potential customer interviews, experts meeting, and literature reading. It also helps to understand relations between each factor in such a complex system.

3.2 Sub Health & Health Care

As we have mentioned in Chapter 2, according to the figures from WHO, most people in the world aged between 20-70 are in sub health status experienced at various degrees. However in this project, solution is not going to solve problems for all these people, just the target group people because they are the one who need the help most.

3.2.1 Target Group Definition



Figure 3. 2 Target Users

The “white-collar” workers and those with higher education levels are more prone to sub health due to the nature of their work and lifestyle. The most affected people are within the ages from 30s-45s. Many people in this age range tend to neglect their health despite experiencing signs from their body that something is not right because that they are in the busiest period of their lives. But not heeding these signals can lead to more serious consequences later. Particularly in this age, metabolism begins to slow down and the physical condition is going down. It is the time when most symptoms of chronic diseases appear.

For all these reasons, people within the ages from 30s to 40s are targeted as the potential users in this project.

3.2.2 Target Group Interview & Their Life

Why does sub health most appear in this age distribution? A story from Doctor Chen tells us something. “One of my patients is a lady in her early 40s. She is in a managerial position and her job requires her to travel very frequently. She told me that she felt that her thought processes seemed to be slower than previously and she would feel tired all the time despite getting a sufficient amount of sleep. In addition, she had poor appetite and general body weakness. She just felt being in pressure even every minute.”

This is just the experience from one of the many sub-healthy people.

In order to know more about these “white-collar” workers, interviews to six persons from four countries were conducted at the beginning of this research.

Interviewees

Name	G	Residence	Job	Marital status
L. Frosch	F	Estonia	Interior designer	Married, has a daughter in 3 years
E. Brusque	M	Brazil	Product designer	Single
H. Y. Sun	F	China	Chief Journalist	Married, has a daughter in 5 years
H. Yang	M	China	Policeman	Married, has a daughter in 6 years
N. N. Nganga	F	Kenya	Student	Single
X. Q. Hu	F	China	Marketing	Married, has a son in 5 years

Figure 3.3 Interviewees' Personal Information

The questions designed in the interview aim to understand whether they are knowledgeable or not about their health, what do they usually do concerning their health care, and some questions about their lifestyle. There are also questions about current solutions, for example their health check up routine and their experience on home-use devices, which can be helpful in finding opportunities.

Questions

Questions about physical state
-How do you feel about your physical state recently? -Do you always feel like that? -Do you know what your physical state is? -How do you know it? / Why don't you know? -Do you usually feel tired? How many days for example within a month? -Do you know how is the physical state of your husband/ wife? -Is he/she in the similar state and has similar problems as you?
Questions about health care routine
- When is the last time that you go to have health check up? -Please describe the process of the health check up you had? -Do you like the process? Why? Which part do you dislike? Why? -What do you usually do when you feel under the weather? -How do you feel when these problems appear?
Questions about sub health status
-Have you heard about sub health status? -How do you think about it? -How do you think that you are in sub-health status or not? -Do you have any worry about your health in the future? -What did you do or is going to do about these worries?
Questions about life style
-How do you usually spend a normal workday from morning to night? -Could you tell me something about your diet and physical practice?
Questions about home-use health care devices
-Have you used any home-use health care device? Why? -Have you thought about trying any? Why? -Does it helpful? Do you believe it?

Figure 3.4. Question list to Interviewees

The results indicate that all of them believe that they know their physical condition but not well enough. They all hope to get more professional help. Only one of them does not think that he is in sub health because that he always feels good and has a balanced lifestyle. Most of them agree that they are often stressed, which is the biggest problem they face. It is noted that they pay attention to health issues not only for themselves but also for their family. However, this attention is only a wish not a behavior because of many time-related reasons. Results also show that only two of them take the health check up once a year. Interestingly, most of them believe that the home-use devices are useful but current products are only for patients. Compared to younger people, all of them have good lifestyle: less drinking, less staying up late, trying to do practice and a balanced diet. I think that they have a sense of risk to their health. But they don't do it well or they cannot do it well. They need some help.

The Life of “White-collar” Workers

The age period from 30 to 40 is important to “white-collar” workers in relation to their career. It is the time things look to be coming together: good opportunities, challenges, achievement, and success. After several years' efforts, many of them are in high positions playing key roles in their work and quite busy. As the chief journalist, H. Y. Sun is a typical example. The time when we met was evening at 19:00 in Sun's office. I had waited for her for more than half an hour, because she had a lot of work including answering the phone, talking to the visitors, and marking a press release. It was past dinnertime and she was still working having eaten no food. However, this is a normal life to journalists, not to mention that she has duty of management. Regardless of profession, busy working is now the common life in modern society.

In this fast-paced world, thousands of people move between cities, countries even continents. It is also a part of “white-collar” workers’ life. X. Q. Hu is responsible for the east China market in her company. Prior to meeting, I had contacted her many times to schedule a meeting time but each time she was in a different city in east China region. “ Some times when I wake up in the morning, I am not sure where I am.” X. Q. Hu said to me. Although, it is better than people who travel between countries suffering from time equation, it still causes endocrine disorders. Actually life on the road really troubles people a lot. In most Chinese cities people usually spend more than 1 hour on the road every day. Anxiety is caused by busy traffic as it becomes heavier. Meeting H. Yang, the policeman was arriving home at 20:00. He took on average two hours driving across the city back home. His office is in the other side of the city. Traffic jam is already one part of his life in this city. Everybody on the road has to be used to it.

Another explanation of busy is working overtime. It is also quite common to “white-collar” no matter what job he/she does. E. Brusque is the one who has the best physical condition in these interviewees. He still looks like a sunny boy despite he is older than 30years old. He attributes it to his happy life: not in a high position, a relatively time flexible work, practicing Shao Lin Kung Fu and single. He feels very well except when dealing with a big design project. As an experienced product designer, he plays a key role in related important projects, creating pressure during that time. During such projects, his average working time is 12 hours per day. According to the project calendar, this crazy schedule can be long or short, but sometimes it lasts more than six months. As well, the chief journalist- H. Y. Sun was facing a night of work after our talk because of an accident.

“White-collar” have spent lots of their time on work and when they go back home, another kind of work is waiting. People aged 30s to 40s are usually in this kind of situation: crucial time in career, kids in childhood, and parents getting weak. They have to be responsible for all these matters. That morning when I met L. Frosch in a Café, she was 5 minutes late because her daughter had developed a sudden ear-pain during the past night. This means she had no rest the whole night. Surprisingly, she still talked with a good smile and looked energetic. After one-hour of talking, she left to her office to start a busy workday. Everything seems normal to her, the sudden sickness of her young daughter, a sleepless night, having breakfast on the run to a day full of work. She just said, “I am fine”, when I asked her how she was feeling after one night without any rest. In a sense, they really have to be fine for their family and their own.

It seems that various things occupy all their time, leading them to usually neglect themselves. Results from these six persons are even very serious. Only two of them have a regular health check up once a year. They receive a report with every item normal but they still do not feel well. They have thought to do something else helpful but they have no time to do anything more. Sometimes, they even have no time to visit the doctor when they are sick.

The problems no matter where they come from just accumulate one by one, a day after a day, eventually placing these people at high risk of disease.

3.2.3 Meet Experts

After talking to target users, I would like to get some information about how the sub health happens in our body, how to deal with them, and more professional acknowledge to guide me in the right way. I prepared some questions before I visited Dr. Chen’s office. Dr. Chen gives me two tests. The first test uses the clinical equipment named “Functional Screening and Computer-assisted Diagnosis”(See *Figure 3.5*), which is designed to analyze the physical condition.



Figure 3.5 Functional Screening and Computer-assisted Diagnosis



Figure 3.6 Self-generated Physiological Coherence System

The whole process is not complex. My head, hands and feet touched electrodes for 4 minutes. All information about my physical condition is read and then a report of diagnosis is showed to me on the computer screen. Obviously, as a woman who is in the target group of this project, I have some sub health problems, for example a slight imbalance in my endocrine system. The cause of my imbalance problem is stress, which can be explained by the analysis of hormone. However, I do not think that I am highly stressed. Dr. Chen gives me the next test: Self-generated Physiological Coherence System. (See Figure 3.6) The bandage attaches to my head with electrodes. It is able to interpret my brain waves into different colors and show on the ball in front of me. In order to prove that I am not stressed, during those few minutes, I feel so calm. The results of this brain test show that I am experiencing high levels of stress. This was a great experience for me. To be able to see what happens in real life all the while collecting answers for my questions.

Causes of Sub Health

Summarize the causes of sub health status including the sociological factors, the psychological factors, and adverse effects of environmental science, lifestyle and genetic factors. It is a result of multiple factors, mainly due to:

1. Overwhelmed feeling from work and life, mental stress, long-term physical and mental fatigue.
2. Lack of rest causes the brain function and autonomic nervous system disorders.
3. Poor lifestyle and behavior leads to body organ dysfunction, metabolic disorders, endocrine disorders, tissue cells lack of oxygen, cell nutrient supply problem, and immune function weak.
4. Environmental pollution from vehicle exhaust emissions, industrial pollutants emissions and foul water, all these problems seriously affects the body's physiological functions.
5. Other factors: the aging of the body's natural circadian clock low tide, and people's emotional quality of life decline.

In conclusion, take all the problems that are out of our control such as pollution, aging, and so on and set them aside, sub health status closely relates to a balance: diet balance, physical balance, mental balance, outer balance and inner balance.

In terms of "white-collar" workers, feeling overwhelmed all the time is becoming the main cause leading to imbalanced condition physically and mentally.

3.2.4 GIGA Map on Sub Health State

GIGA map is an effective approach in complex problem analysis, which is usually used as the main tool in system oriented design. It asks for visual thinking together with material collecting, interview, prototyping and any other design thinking tools. In general research with this tool, I try to find an interesting point by illustrating any related factors as much as I can. Information from internet research, talking to the doctor, my great test experience, interviews to potential

customers and reading literatures are divided into four groups: Sub health condition, Health check up, Solution for health care and ICT-based on technology. The most valuable result worked out is the relationship between these matters. These linked matters have already narrowed the problem range and give some possibilities.

The most valuable possibility is that ICT technology has already contributed much in health care system. Many new concepts are proposed. Some platforms for Internet health care are built. Companies are trying to push the development of Internet health care service through establishing collaboration between companies, medical institutions and governments. It is already an active market. It also provides opportunities to new ideas on sub health.



Figure 3.7 GIGA map

3.2.5 Conclusion

In the fast-pace tempo of contemporary life, “white-collar” workers seem a little helpless. They have to integrate themselves in the fast pace, adapting, bearing and competing. Stress is a part lingering in their life. The research in functional medicine makes stress as the most serious problem that impacts the health of people. It is an invisible danger around us anywhere and anytime. An experiment conducted in 1991 by S. Cohen, Tyrrell and Smith indicates that stress increases the likelihood of even illness and none of factors like age, sex, health habit that moderate the stress—illness relationship make a difference. There is a direct relation between stress sub health and illness (See Figure 3.8). In order to help “white-collar” to get rid of sub health status approaching inner balance, stress is targeted as the main problem that we need to solve in this project.

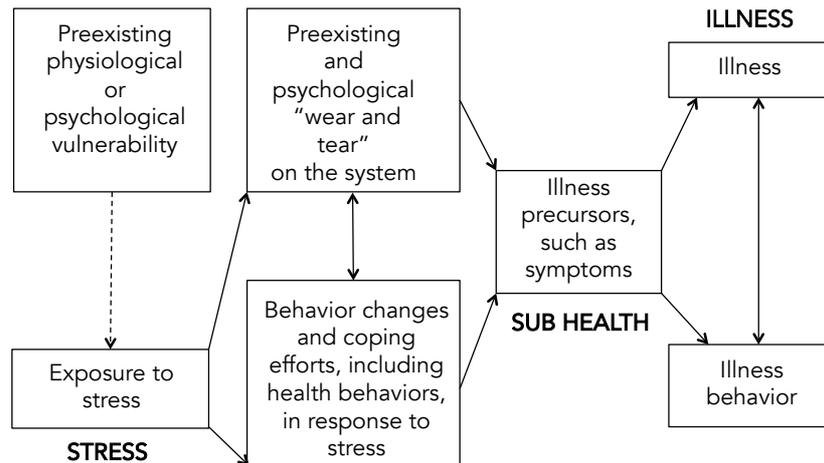


Figure 3.8 the stress-Illness Relationship

3.3 Stress & Stress Management

Stress is a relatively abstract idea. As we talked before, it is invisible but around us impacting our life. Everybody has experienced stress but not everybody understands what stress is. In psychology science, stress is a hot topic. Much study in this field has defined that stress is a sort of negatively physiological and emotional experience. People are able to manage it by learning management skills. Two topics will be discussed in this phase: what is stress, and what is stress management.

3.3.1 Stress

Stress can be defined as a negative emotional experience accompanied by predictable biochemical, physiological, cognitive, and behavioral changes that are directed either toward altering the stressful event or accommodating to its effects (A. Baum, 1990). Actually, stress has been conceptualized in many ways. No matter which way it is conceptualized, stress is a concerted reaction involving nervous system immune system and endocrine system. Therefore, in experience, stress can be simply described as sequence physiological consequences and emotional responses.

Stress produces physiological arousal, which is reflected in the functioning of many of our body systems---for instance, our heartbeat and breathing rates increase immediately, blood pressure and pulse rate increase as well (Shelley E. Taylor 1995). Additionally, sweating, skin conductivity and skin temperature go up at the same time. Also the brain wave is in quite active situation. These responses are very close to a study result from the distinguished physiologist Walter Cannon in 1929. He calls these physiological reactions fight-or-flight responses because they prepare the organism to attack the threat or to flee. In the fight-or-flight response, the perception of danger causes the sympathetic nervous system to stimulate the adrenal glands of the endocrine system to secrete epinephrine, which arouses the body. That is why "white-collar" is high stressed when they are in challenge and competition. But the state of high arousal can be harmful to health if it is prolonged.

Stress can also lead to feelings of depression, fear, anxiety, anger and so on. Normally, people also have these feelings at times, but these emotional responses differ from normal emotional change. The difference between them as a serious disorder is a matter of degree. Normal emotional change becomes a psychological disorder when it is severe, frequent, and long lasting. People with this disorder tend to:

- Have a generally unhappy mood
- Feel hopeless about the future
- Appear listless and passive
- Show disrupted eating and sleeping habits
- Have low self-esteem, often blaming themselves for the troubles that afflict them (Rosenhan & Seligman, 1984)

3.3.2 Stress Management

When people experience stress in their lives, they usually try to manage it by trying out different ways of thinking or behaving: sleeping, crying, breaking stuffs, shouting, smoking, over drinking, complaining, excessive eating, and so on. Some conversations from a stress study tell us what they usually do (*Shelley E. Taylor 1995*).

"I used to depend on drinking a lot to change my mood. Once in a while, I still find that if I can't feel better any other way, I will take a puff of grass or have a glass of wine, or I use music. There are certain recordings that can really change my mood drastically. I play it loud and I dance around and try to clear my head."

"I do exactly what I want to do, as much as possible, things that amuse me, entertain me, and pamper me."

"There's an old disco song that says: Keep out of my mind what's out of my hands. I try to do that, to not fret over things I really don't have control over."

"It is important to me to focus on something besides the difficulties."

"I drive. I feel so much more at peace when I am driving down the road in a car, listening to music, having my dog next to me. It is wonderful."

"When you're sad, you cry. That's what I have done a lot, over silly, well, it makes me feel better."

Individual's coping responses are often spontaneous; that is, people do whatever comes naturally to them and what has worked in the past. But sometimes these efforts will not be enough. The stressor may be so novel, so chronic, or so elusive that people's own efforts may be unsuccessful in reducing stress. Moreover, as we have seen, individual efforts to control stress are not always adaptive, especially in the long term. Coping with chronic stress through excessive alcohol or drug use, for example, may bring relief in the short run, but often the person is worse off for these efforts; the source of stress itself remains unchanged. Therefore, when people cannot cope effectively, they need help in learning new and adaptive ways of managing stress (*Edward P. Sarafino 1994*).

In terms of stress coping strategies, the experts' opinions are that the process of stress management should include factors from different sources. Stress measurement helps to know our inner balance level. Relaxation training is helpful to increase the physiological stress resistance, which is like regular physical practice, jogging, Indian Yoga, Chinese Tai Chi and so on. For each individual, people need to learn the skill of personal control for example meditation and conscious breathing. It is the best solution to help them timely calm down when they are stressed. Furthermore, social support that includes professional help, support from communities and clubs goes up the satisfaction of their life.

3.3.3 Stress Management System

Doctors and psychologists increasingly pay attention to developing techniques of stress management. They make these techniques tend to be a support system, which starts from stress generation going through sequence conscious behaviors approaching a balanced state physically and mentally.

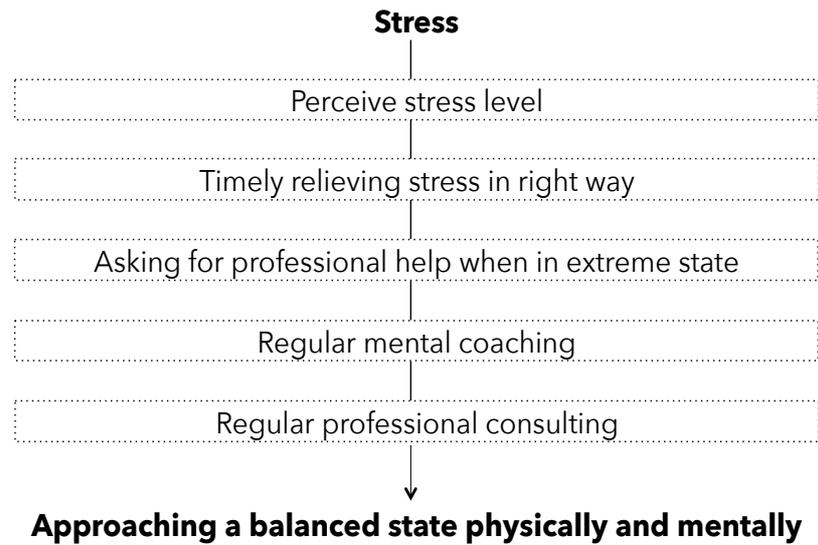


Figure 3.9. Stress Management System

As the Figure 3.9 explains, this management system involves several phases. In the first stage, by measurement, people get to understand what inner condition they are in. In the next stage, people learn skills to cope with stress timely when they are in suffering situation. At the same time, they need to ask for other help, for example professional help if they are in extreme state. In order to get real balance, some practice is recommended doing regularly, for example doing it once a day. If people want to manage stress more effectively, it is better to have professional consulting after a period.

To summarize, stress management is a service system including various sources and a skill that people need to learn to cope with their stress approaching an inside balance.

3.4 Target Problem Definition

People need to know that they are at disease risk because of high stress, and learn to relieve stress in a right way anytime and anywhere when they are stressed to get inside balance.

4. Clinical Solution Development

It is clear now, the main task I need to do for stressed “white-collar” is to design an effective solution, which makes people know that they are at disease risk because of high stress and help them in learning a skill to relieve stress in a right way anytime and anywhere when they are stressed to get inside balance. Studies in this chapter is in the DEFINE phase in Double Diamond Model. Targeting the problem that I have defined in chapter3, I am going to develop the clinical solution to define the final product concept in this chapter.

4.1 Method

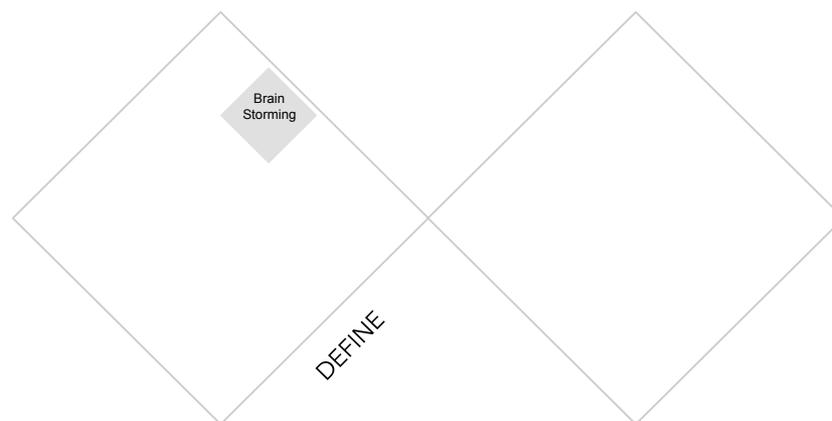


Figure 4.1 Method in DEFINE Phase

In this chapter, the method of brainstorming is used in developing the clinical solution. Brainstorming is used to generate the alternative solutions and the opportunities quickly. It identifies the most interesting or important ideas to take forward as part of the design process. Brainstorming is particularly useful to break out of established patterns of thinking, and develop new ways of looking at things. It also helps to overcome many of the issues that can make group problem solving a difficult or unsatisfactory process (*Ursula Davies, Kelly Wilson from Design Council, UK*). Brainstorming asks for as many as possible solutions on the target problem. Analysis on various ideas helps to create an interesting new idea. In the beginning, not any solution about stress management is negated. Searching any solution in present market can be helpful to figure out a really interesting and effective solution. In order to get a relatively best solution, comparison is usually needed as well between similar solutions. Brainstorming is also helpful to have deeper understanding in this comparison.

4.2 Present

People have realized the harm caused by stress. As we have discussed in the last chapter, they try to figure out different ways to cope with their stress, but the ways are not limited in thinking and behavior. Technology developments bring them more alternatives. Currently, there are many products in the stress-related market.



Figure 4.2. Stress-related Solutions in Current Market

The most popular product called stress reliever toy is usually made from elastic materials, for example foam. It has a funny shape and has a deformation when people squeeze it. It is designed for the time when people in anger or being oppressive. At the squeezing moment, it helps people to release the strong negative emotion, and the funny deformed shape brings a kind of relaxation. Some products with similar function like the bubble wrapping and the yell vase all try to take stress off at the very stressed moment. These are products derived from people's natural behavior such as shouting and breaking stuff. However, some products try to work in another way. It seems that they are derived from Eastern massage. The principle is that opening up the meridians is able to make people relax and feel comfortable. This idea is also used in some furniture, which is designed specially for stress relieving. Some electronic instruments can also be found in the market. They work based on different principles. Some are based on biofeedback, some are based on creating a nice atmosphere and some are based on relaxation training. There are even products being based on chemical principle. Some objects have the carbon-porous structure, which absorb harmful substances in the air. People believe that fresh air in a space is also helpful to release their stress.

As we have discussed in last chapter, coping efforts are judged to be successful when they reduce physiological indicators of arousal, enable the person to return to pre-stress activities, and free the individual from psychological distress (*Shelley E. Taylor 1995*). In order to know which solution works well, one question is essentially to be answered: What is happening in our bodies when we are stressed?

4.3 Stress & Biofeedback

We have already known that stress is a physiological and emotional response in our bodies. Sometimes, people can feel it as anxiety, depression or excitement. Sometimes, people cannot, because stress is a result dominated by autonomic nervous system. The development of biofeedback helps us to understand what exactly happens in our bodies when we are stressed, and what feedback we can get from those physiological responses. The results from studies in this phase are going to be the basic principle of the clinical solution.

4.3.1 Stress & Physiological Response

As the definition explains, it is known that stress produces physiological arousal, which is reflected in the functioning of many of our systems. The most involving system is Autonomic Nervous System (ANS), The body's autonomic nervous system governs many of the body's internal functions, through its two branches: the sympathetic (SNS) branch of this ANS activates or increases the heart's action, while the parasympathetic branch acts as a brake slowing the action of the heart. The vagus nerve plays the role of the parasympathetic (PNS) braking action. Normally, ANS acts as a harmony, which is a peaceful situation of the interaction between sympathetic nerve and parasympathetic nerve. The balance between this throttle and brake system produces an ongoing oscillation, an orderly increase and decrease in heart rate (*Donald Moss 2004*). These autonomic inputs are mediated by two "pacemakers" in the heart: the sinoatrial (SA) and atrioventricular (AV) nodes, which are responsible for heart

rhythms. The SA node initiates an electrical signal, which begins each cycle of the heart's pumping action. This signal passes through the AV node, which spreads the electrical current through the ventricles of the heart. A variety of factors, including breathing, pressure sensors in the arteries, the body's thermal regulation, and anxious thinking, increase specific rhythms in heart activity. The overall process of heart function is the end product of these component rhythms (*Donald Moss & Fred Shaffer 2004*).

When we are experiencing acute stress, there is a temporary increase in SNS arousal that activates our "fight or flight" response to help us deal with the demands of the stressful situation, and when the stressful situation is resolved or ended, there is a subsequent increase in PNS activity to turn off the stress response and bring us back into a more balanced state. With respect to heart rate, an acute stressor results in a SNS-driven stress response that increases our heart rate, and once the stress is over, the increasing PNS input should quickly bring the heart back to its normal, slower rhythm. Unfortunately, when stress becomes chronic or is driven by ongoing negative thoughts and emotions, we become stuck in SNS over-drive and the PNS becomes ever less effective in countering the SNS (*Horst H. Mueller 1994*). (See *Figure 4.3*)

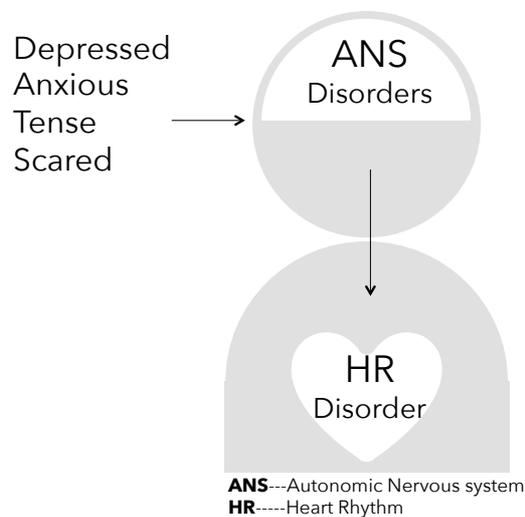


Figure 4.3 Physiological Responses

4.3.2 Physiological Response & Biofeedback

Biofeedback is a technique, in which an electromechanical device monitors the status of a person's physiological processes, such as heart rate, brain wave or muscle tension, and immediately reports that information back to the individual. This information enables the person to gain voluntary control over these processes through operant conditioning (*Edward P. Sarafino 1994*).

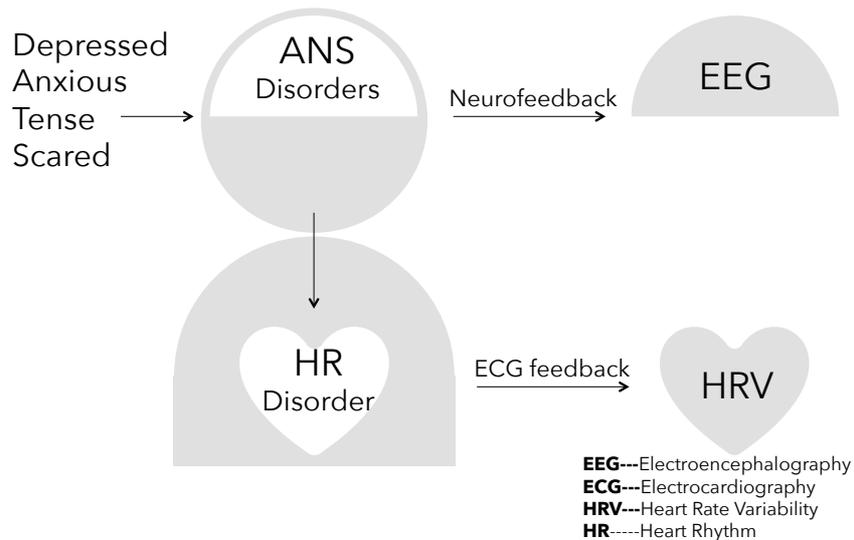


Figure 4.4 Physiological Response & Biofeedback

As figure 4.4 showed, the ANS disorders can be monitored by electronic instruments through Electroencephalography (EEG) and Electrocardiography (ECG) in a specific signal. Heart Rate Variability (HRV), which is one of the ECG biofeedback techniques, indicates the rhythm of the heartbeat. For example, if there is an enhanced and unstable heart rate read by ECG instruments, HRV digraph is going to report a specific signal as well. These techniques provide people an effective assessment to collect information about stress impact on their bodies. It is also the popular method in the first stage of stress management in Internet era: get to know whether people are in stress or not and how much level they are at.

4.3.3 Biofeedback Solution Analysis

Biofeedback has been used successfully in solving stress-related problems for example difficult concentrating, dizziness, hypertension, fatigue syndrome and so on. EEG and HRV are the most widely used biofeedback techniques. There are various products based on each technique. Some are running in ICT concepts. Next chart (See Figure 4.5) is a comparison between these two techniques and various products developed from these techniques.

	EEG		HRV
Solution	Meditation	Grapheme	Breathing
Content	Sensor on head + Music & Guidance	Sensor on head + Graph or Game	Sensor on wrist, chest or ear Etc. + Guidance or Game
Products			
Effects	Good for relaxation and neuro-coaching	Better for attention training	Not only benefit relaxation but also heart and blood pressure
Evaluation	-Professional guidance is essential -Require highly for environment -Hard to follow -Complex data analysis	-Interesting -Many alternatives for users -Complex data analysis	-Professional guidance is essential -Easy to follow -Quick response

Figure 4.5 Biofeedback Solution Analyses

Biofeedback techniques in solving stress-related problems are usually technology-integrated solutions. Biosensors and some multimedia tools such as computer application, music and digital game, work together to create a clinical solution. EEG neurofeedback is more used in treating people who have brain-involving difficulties, for example difficulties in concentrating, irritability, insomnia and so on, especially for children in attention coaching. Two solutions are popularly used: Meditation and Grapheme. These two solutions have similar contents. For example, solutions designed by Neurosky Company for relaxation training and attention training have a same basic head-attached sensor. The only difference between these two solutions is the APP used in training. People attach the sensor to their heads downloading music and professional guidance to practice meditation. In grapheme, people need to download game or APP with specific graph to practice concentrating.

Differently, HRV biofeedback solutions can be used in more ways. This physiological arousal can be measured through the pulse, which means the wearable sensor can be attached to the wrists, chest or ears. The typical measure node in clinic is on the chest. But with the development of this technique, the pulse can be read through HRV feedback on wrists, fingers and ears. Different products are developed by different measuring ways. There are earphone-like products and bracelet-like products in HRV-related product market. The treating way of HRV-related product is breathing. People use HRV sensor to know their ANS conditions. As we have talked before, activities of ANS indicate the stress level. Some stress detectors are derived from this biofeedback plus the professional guidance, music or game to become a stress release trainer. How do these solutions work?

The above comparison gives results in two characters: Effects and Evaluations. The meditation solution is good for relaxation training and neuro-coaching, but it asks for working in a very quiet space. As many trainers experienced, meditation is a process very difficult to follow, sometimes, if people try to control it without professional guidance, it may lead to an accident. From the technology point of view, the brain waves are sequences of data in different frequencies. The analysis on the feedback data is a big work for the developers. Another neuro feedback solution grapheme seems interesting. It provides many game alternatives to the users and gives them some fun but it is better for attention coaching on children than relaxation training on the stressed people. Breathing has been identified as an effective way for releasing stress. Some studies indicate that conscious breathing can benefit also heart disease and high blood pressure. In addition, breathing is a skill to follow easily. It has quick response on our bodies. People can get positive feedback for example lower heart rate in minimum 3 minutes if they do the breathing training following the right guidance.

In conclusion, the above comparison and analysis go towards the solution that one of the most effective approaches for releasing stress is the HRV- involving conscious breathing.

4.4 Clinical Solution of Stress Management

The HRV biofeedback and conscious breathing will be the basic techniques of the clinical solution for stress management. Being based on these two techniques, there are some interactions between the sensor and our bodies. In this phase, the studies aim to have deeper understanding about the HRV biofeedback and the conscious breathing skills, then to figure out an effective and feasible clinical solution for stress management.

4.4.1 HRV

By variability we mean changes in the interval or distance between one beat of the heart and the next. The interbeat interval (IBI) is the time between one R-wave (or heart beat) and the next, in milliseconds. The IBI is highly variable within any given time period. Multiple biological rhythms overlay one another to produce the resultant pattern of variability. Interbeat interval variations, or heart rate variability, have relevance for physical, emotional, and mental function. Many people confuse Heart Rate with Heart Rate Variability. The human heart is a bioelectrical pump beating at an ever-changing rate: it is not like a clock that beats at a steady, unchanging rate. This variability in heart rate is an adaptive quality in a healthy body (*Donald Moss & Fred Shaffer 2004*).

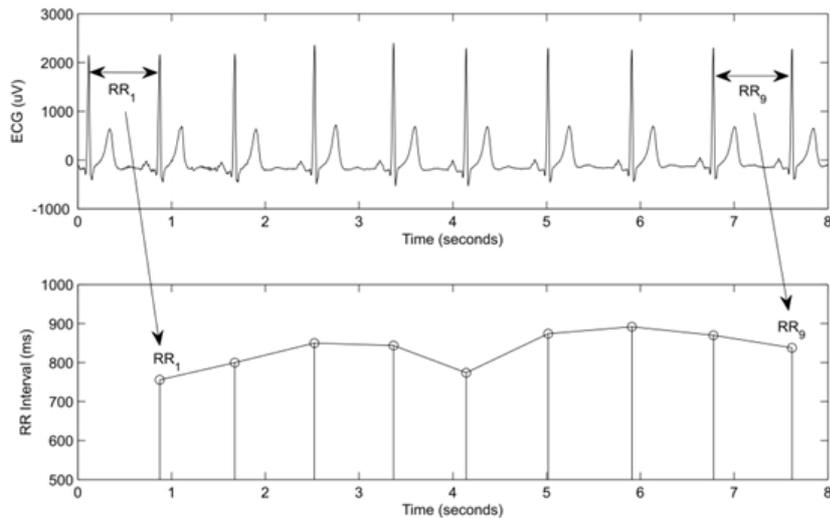


Figure 4.6 Heart Rate Variability

A study in HRV works out some results, which show the differences between the heart rate and HRV (<http://wenku.baidu.com/view/7650ffd726fff705cc170a7d>).

The following list shows the figures of three indicators from ECG test during ten short-terms (each short-term is 1 min) on a detected person: Heart rate, MEAN (R-R interval in a period), and HRV.

	Heart Rate (B/min)	MEAN (ms)	HRV (ms)
1	74	812.3	49.8
2	71	849.7	50.0
3	70	855.5	33.0
4	74	811.4	35.4
5	67	881.6	97.9
6	58	1034.2	94.7
7	65	911.4	268.0
8	86	691.2	211.7
9	93	641.4	41.6
10	103	579.9	98.6

Figure 4.7 Figures of Heart Rate, MEAN and HRV From a Test

It is easy to find that HRV acts different in similar Heart Rate state. It explains why the ANS activity is different when people seem calm. That is why it is defined as the best indicator in clinical use to assess chronic stress.

4.4.2 Stress & HRV

The relation between the stress and the HRV feedback can be explained with ANS activities (See Figure 4.8). The SNS accelerates the heart; whereas the PNS acts as a brake decelerates the heart. When the two systems are working in proper balance, the heart becomes exquisitely responsive to the body's ever changing needs and yet maintains a strong underlying stability. When the two systems are not working well together, the heart shows a poor response to changing body needs and less stability in heart rate at rest. Chronic stress leads to autonomic imbalance with increased SNS activity and reduced PNS influence and shows up as increased resting heart rate and reduced heart rate variability. In effect, the autonomic nervous system is running like a car on the highway that is being driven by a person who has the gas pedal floored at the same time as they are constantly applying the brakes. This type of driving is going to invariably cause the brakes to wear out and fail and will cause increased wear and tear on the engine and transmission. Try to imagine a powerful car with a very sensitive and twitchy gas pedal and very poor brakes (Horst H. Mueller 1994).

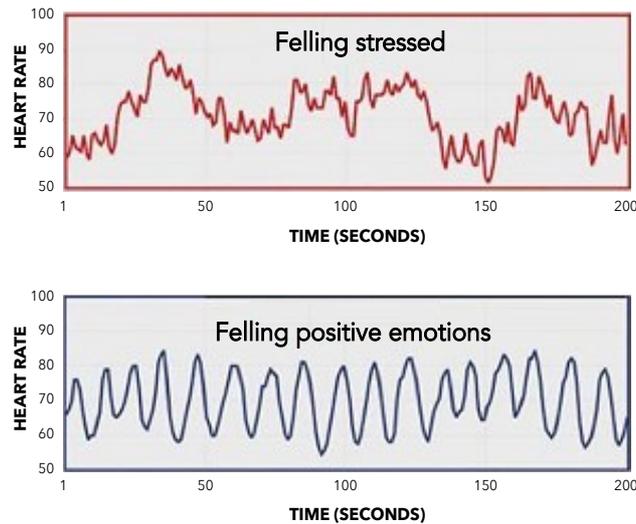


Figure 4.8 HRV and Emotion

The above chart shows the HRV graph from ECG. After signal filter, the HRV pattern is huge changed when people feel stressed and feel positive emotions. The positive emotions lead to a regular Sinusoidal-like wave, conversely, the negative emotions lead to an orderless graph. This visible and measurable result directly explains how the HRV describe the stress change in peoples' bodies. It provides an effective tool in developing stress-relieving solutions.

4.4.3 HRV Index

HRV is a heart rate-involving function that can be simplified as the speed of heart rate changing under the influence of ANS. The unit of HRV is millisecond. The higher Heart Rate Variability means that the heart rate changes from A to B needs more time. It indicates a more stable heartbeat and an optimal cooperation between the sympathetic and parasympathetic nervous systems. It also explains that HRV feedback treatment can be used in the circumstance when people are running. This time domain is the main index in HRV. The index in frequency domain indicates the power of the sympathetic and the parasympathetic. The frequency range of R-R waves is approximately defined between 0--0.5 Hz. Low frequency is defined between 0.04—0.15 Hz, and High frequency is defined from 0.15—0.4Hz. Low frequency indicates the power of the sympathetic nerve, and high frequency indicates the power of the parasympathetic nerve. Usually, the percentage of LF and HF are used to assess the results of ANS regulating training. Some clinical used index is listed in the following chart (<http://ir.lib.cyut.edu.tw:8080/retrieve/28334/201108.pdf>):

Index	Physiological Indication	Normal	Dangerous	Symptom	Treatment
HRV (ms)	Stability of Heartbeat Rhythm	25-80, (Average 40)	<15	ANS disorders	Increase to >15
HF (%)	Power of PNS	40-60	<30 or >70	Low power of PNS	Increase to 30--70
LF (%)	Power of SNS	40-60	<30 or >70	High power of SNS	Decrease to 30--70

Figure 4.9 HRV Index

	30y	35y	40y	45y
HRV (M)	41	36,	31	29
HRV (F)	44	39	34	31

Figure 4.10 HRV & Age, Gender

As human beings age or suffer illness, the total variability in heart rate is reduced, and the risk of illness and death increases. List the different index in different age for male and female to provide a reference in software development and APP design in the future work. It is also related the user interface design. In this phase, the indication used in this project can be identified as following chart (<http://ir.lib.cyut.edu.tw:8080/retrieve/28334/201108.pdf>).

HRV	20-40	<20	>40
Indication	Low stress level	High stress level	Normal

Figure 4.11 HRV Index

4.4.4 Breathing & ANS

The above discussion in this phase focuses on how the HRV feedback technique works to indicate the activities of the ANS by the influence of the stress. It is the stress meter in peoples' bodies. Up to now, the method of stress measurement has been figured out. In this phase, discussion is going to focus on the treating method---the conscious breathing.

Being known, the rhythm of the heart is primarily under the control of the parasympathetic nerve, which inhibits heart rate and the force of contraction. When people inhale, the sympathetic nerve is active and the parasympathetic nerve activity is impeded, then the heart rate begins to increase. When people exhale this pattern is reversed. (See Figure 4.12) This is the relation between the ANS activities and the breathing. It is the fundamental stress-treating principle.

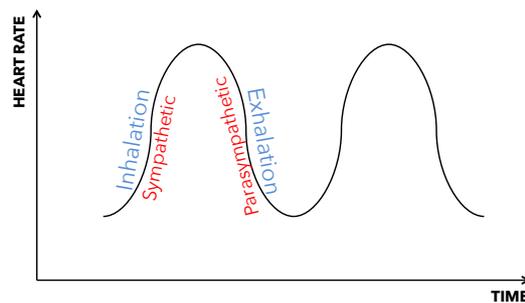


Figure 4.12 Breathing & ANS

In terms of stress-treating principle, the breathing here is not the natural breathing like people doing in every second. It can be called conscious breathing, which is a depth-involving and rate-involving breathing skill. Breathing in different depth and frequency responses the different ANS activities, which means it also responses people in different inside state (See Figure 4.13).

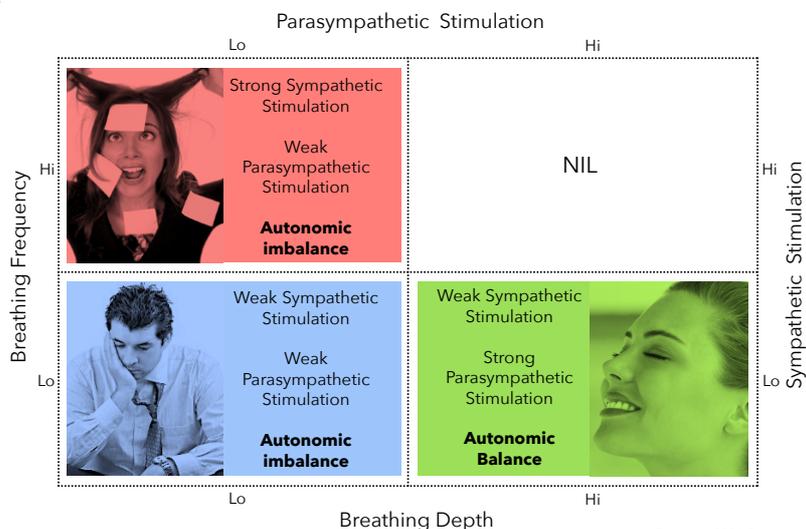


Figure 4.13 Breathing & ANS

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A high frequency and low depth breathing indicates a strong sympathetic stimulation and a weak parasympathetic stimulation, which makes the ANS imbalanced. People who are in this breathing are usually stressed in anxiety, and streakiness. A low frequency and low depth breathing responses that both the sympathetic stimulation and the parasympathetic stimulation are weak. It makes the ANS imbalanced as well. People who are in the weak autonomic activities of both the SNS and the PNS are usually low-spirited. Only the low frequency and high depth breathing is able to regulate the ANS approaching a balance. In the balanced ANS activities, the SNS stimulation is weak and the PNS stimulation is strong, which is the goal in the stress-treating solution.

4.4.5 Breathing Work Principle

The conscious breathing with low frequency and high depth has been defined as a treatment of stress syndrome. The biofeedback practitioners also have found that some sorts of conscious breathing training can effectively increase HRV, through several parallel training pathways. As figure 4.14 shows, the work process from conscious breathing to higher HRV has several physiological responses involving in. The low frequency and depth breathing firstly increases the activity of the parasympathetic nerve, at the same time, the sympathetic nerve activity is impeded, which lead to the ANS balance. Therefore, the lower frequency heartbeat is more rhythmic. Then the HRV feedback gives a higher result. This process is the principle of solution in this project for stress management. The stressed trainees are guided to acquire three basic skills: 1) relax physically and emotionally, 2) reduce anxious thoughts and negative emotions, and 3) engage in smooth full diaphragmatic breathing. Next, the trainees learn to recognize and produce the smooth sinusoidal-like wave forms, in which respiration and heart rate covary in a near-phase or complete phase relationship.

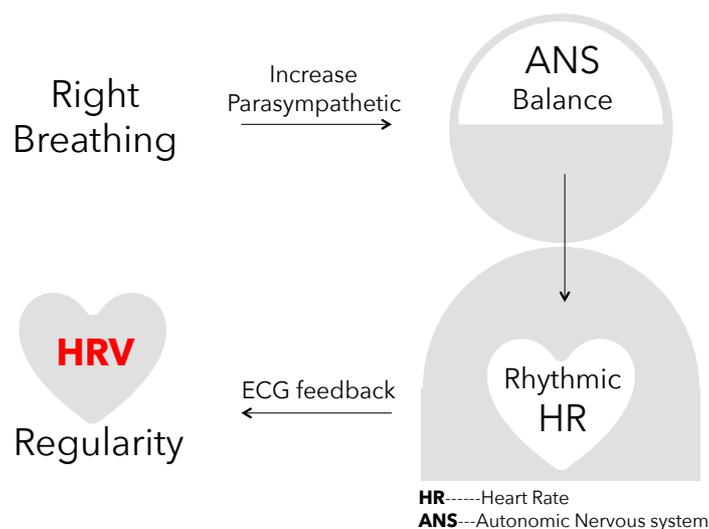


Figure 4.14 Breathing Work Principle

4.4.6 Conscious Breathing

Unlike other bodily functions, the breathing is easily used to communicate between the body-mind, the conscious-unconscious, and the ANS, which gives us an excellent tool to help facilitate positive change. It is the only bodily function that we do both voluntarily and involuntarily. We can consciously use breathing to influence the involuntary SNS that regulates blood pressure, heart rate, circulation, digestion and many other bodily functions. Conscious breathing exercises can act as a bridge into those functions of the body of which we generally do not have conscious control.

(<http://www.amsa.org/healingthehealer/breathing.cfm>).

There are some sorts of conscious breathing technique. Each individual has a “resonant frequency” at which heart rate variability is the greatest, and this resonant frequency can be measured by biofeedback instruments. While there is no uniform “ideal value” for all persons, this resonant frequency is most frequently produced by persons in a relaxed mental state, with a positive emotional tone, breathing diaphragmatically at a specific rate of about 5-7 breaths

per minute. Relaxed breathing at around six breaths per minute produces a spike of heart rate variability at around 0.1 Hz (*Gay Hendricks 1995*).

The diaphragmatic breathing is called Abdominal breathing, which is the most popular breathing tool in relaxation training and personal control.

4.4.7 Abdominal Breathing Technique

Abdominal breathing is also known as diaphragmatic breathing. The diaphragm is a large muscle located between the chest and the abdomen. When it contracts it is forced downward causing the abdomen to expand. This causes a negative pressure within the chest forcing air into the lungs. The negative pressure also pulls blood into the chest improving the venous return to the heart. This leads to improved stamina in both disease and athletic activity. Like blood, the flow of lymph, which is rich in immune cells, is also improved. By expanding the lung's air pockets and improving the flow of blood and lymph, abdominal breathing also helps prevent infection of the lung and other tissues. But most of all it is an excellent tool to stimulate the relaxation response that results in less tension and an overall sense of well being (<http://www.amsa.org/healingthehealer/breathing.cfm>).

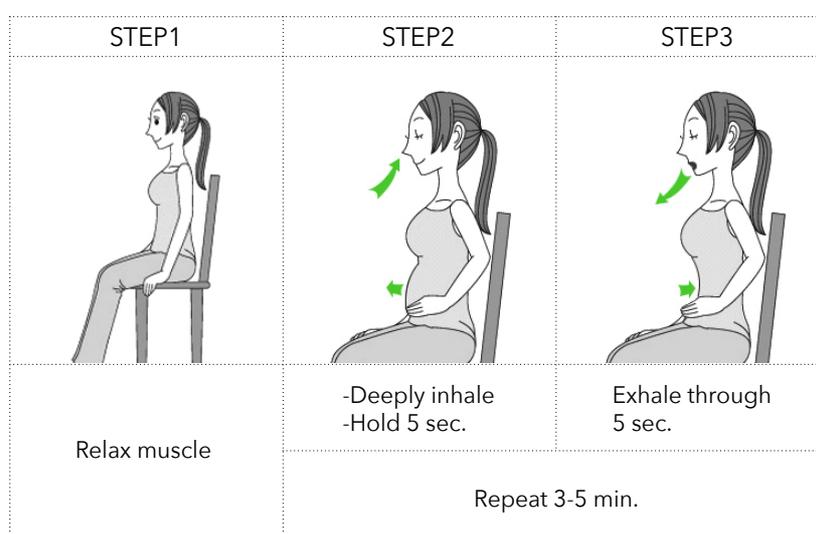


Figure 4.15 Abdominal Breathing

The theory of abdominal breathing in detail divides into several practicing steps (See *Figure 4.15*):

Step1. Relax physically and emotionally. Reduce anxious thoughts and negative emotions by exhalation. Place one hand on your chest and the other on your abdomen. When you take a deep breath in, the hand on the abdomen should rise higher than the one on the chest. This insures that the diaphragm is pulling air into the bases of the lungs.

Step2. After exhaling through the mouth, take a slow deep breath in through your nose imagining that you are sucking in all the air in the room and hold it for a count of 5 (or as long as you are able, not exceeding 7).

Step3. Slowly exhale through your mouth for a count of 8. As all the air is released with relaxation, gently contract your abdominal muscles to completely evacuate the remaining air from the lungs. It is important to remember that we deepen respirations not by inhaling more air but through completely exhaling it.

Step4. Repeat the cycle four more times for a total of 5 deep breaths and try to breathe at a rate of one breath every 10 seconds (or 6 breaths per minute). At this rate our heart rate variability increases which has a positive effect on cardiac health.

Once you feel comfortable with the above technique, you may want to incorporate words that can enhance the exercise. Examples would be to say to yourself the word, relaxation (with inhalation) and stress or anger (with exhalation). The idea being to bring in the feeling/emotion you want with inhalation and release those you don't want with exhalation.

In general, exhalation should be twice as long as inhalation. The use of the hands on the chest and abdomen are only needed to help you train your breathing. Once you feel comfortable with your ability to breathe into the abdomen, they are no longer needed.

4.5 Conclusion

The HRV biofeedback is proved as one of the most effective techniques in stress measurement. It directly responses peoples' ANS activities and indicates peoples' stress level. Based on this technique, people are able to know whether they are stressed or not in anytime and anywhere. The abdominal breathing is a skill that people is able to learn. It solves the second problem of stress management: relaxation training. Till now, a clinical stress management solution is figured out:

People get to know whether they are in stress or not through HRV biofeedback, and take training such as abdominal breathing to relieve stress in a right way when they are stressed.

5. Solution Experiment

Theoretically, the clinical solution for stress management is feasible. There are already some similar principle products in the market. But experiments are still needed to improve current ideas or create some new ideas.

5.1 Method

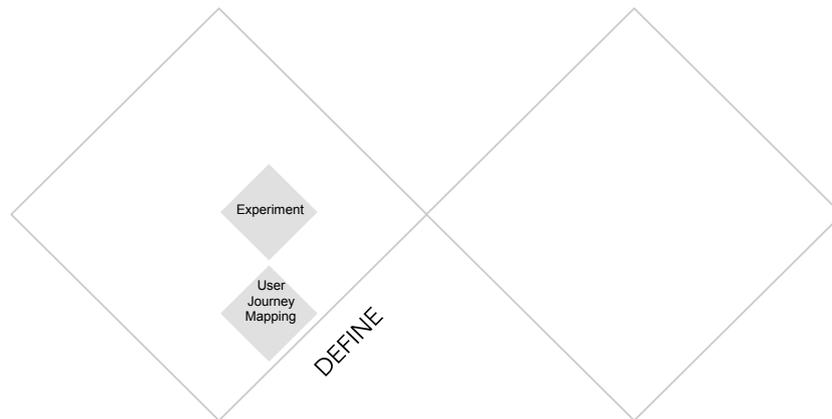


Figure 5.1 Method in DEFINE Phase

This is an experiment chapter. A refitted prototype from a similar principle product gives the target users tests on stress measurement and abdominal breathing training. This experience prototyping is a way of testing new solutions or designs for specific interactions. It is about communicating what the experience will be like and allows the designers to test and refine their solutions with potential users. Aims of using this method is to design and test specific interactions, to find out whether parts of the solution meet users' needs and how they can be improved, and to gather feedback from potential users (*Ursula Davies, Kelly Wilson from Design Council, the United Kingdom*). During this experiment process, user journey mapping is used to analyze feedbacks and interactions from the experience prototyping. A user journey map is a visual representation of a user's journey through experiencing a solution, showing all the different interactions they have. This allows designers to see what parts of the solution work for the user and what parts might need improving (pain points). A user journey map takes the user's point of view and explains their actual experience of the solution. Aims of using this method are, to identify the key elements of a solution, to understand the links between all the different elements over time, and to identify problem areas in a solution (*Ursula Davies, Kelly Wilson from Design Council, the United Kingdom*).

5.2 Experiment Purpose

In order to test can this solution work and how it works, an experiment is conducted in the JOINTECH Company in China. 18 staffs are picked to take this experiment. Their age and job meet the definition of the target group. Firstly, the experiment equipment is refitted from a similar HRV sensor bought in the market. It includes the main HRV module and a finger-attached sensor (See *Figure 5.2*). The initial idea of this project is going to work on wrist, the electrodes of the sensor are refitted to a simple contactor taped on the wrist (See *Figure 5.3*).



Figure 5.2 HRV Sensor



Figure 5.3 Wrist-attached Electrode

This experiment aims to get answers of these following questions:

1. How does the HRV sensor work in measuring?
2. Do the electrodes work on wrist?
3. How does the abdominal work on stress relieving?
4. What is the problem of experience in the whole process?

5.3 Figures from Experiment

HRV	<20	20-40	>40	SUM
Indication	High stress level	Low stress level	Normal	
Before breathing training	5	9	4	18
After breathing training	1	7	6	14

Figure 5.4 Experiment Figures

From the beginning to the end, the test on each staff takes approximately 15 minutes. The HRV index is referenced the one we have defined before. In the first step, the measurement results show that 14 of these 18 detected staffs are at different stress levels. 5 of them are very stressed by the HRV lower than 20. 14 stressed staffs continue to the second step of this experiment: the breathing training. Each staff is asked to do the abdominal breathing following the sample sine-like wave on computer screen for 5 minutes. The results of the HRV feedback show that 6 of them increase their HRV above 40, and there are still 8 staffs stressed. These are the results gotten from the HRV feedback. The process is more interesting and much information included.

It seems that the HRV feedback works well in measurement on wrist. It shows that people are stressed. It tells someone that they are in stress although they look fine. This is the most valuable part of the HRV feedback to people. It helps people to know the inside conditions and pay attention to the invisible danger.

Unfortunately, from the experiment figures, we know that the abdominal breathing training does not work well. Behind these figures, more details show that 4 high stressed staffs increased their HRV above 20 after abdominal breathing training; 2 even increased their HRV above 40 to a normal state. 9 staffs are at medium stress level. Their HIV biofeedback is between 20 and 40. After breathing training, 4 of them increased their HIV obviously above 40. But 5 of them still get their HRV feedback between 20-40. Comparing their measurement result; there is not much improvement after abdominal breathing training. One high stressed staff is still in the 20-lower dangerous state after abdominal breathing.

To sum up, there are 8 subjects succeeded and 6 failed in this experiment. In the 8 succeeded staffs, 6 of them get balanced ANS through abdominal breathing and 2 make themselves reduce the high stress. The following pictures show how the HRV feedback changes on one succeeded staff during this process.

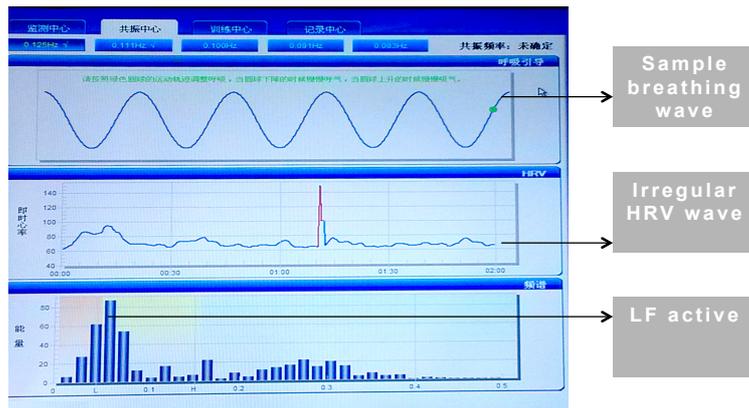


Figure 5.5 Report of Measurement

From the report of measurement (See Figure 5.5), it is obviously that this staff is experiencing stress because the HRV is in irregular wave and heart rate changing range is narrow. In this inside condition, low frequency power increased. It means the sympathetic nerve is active. After few minutes abdominal breathing training, HRV and the ANS branches' power change a lot (See Figure 5.6), HRV wave is more regular approaching sine-like wave, and the HF is more powerful.

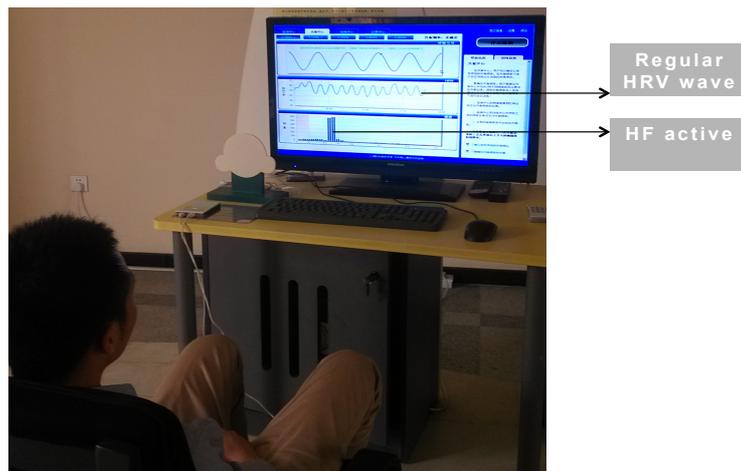


Figure 5.6 Report of Training

In terms of the 6 failed subjects, causes are all from the abdominal breathing training process. 4 of them said that they try to act the abdominal breathing as taught before experiment. But from the beginning to the end, they cannot do it well. This unnatural breathing way makes them uncomfortable. Actually, during the training process, they feel tired to the abdominal breathing technique. Other 2 failed staffs experience different story. They feel well during the training process and they thought that they might have good training result, but do not since they did not breathe in abdominal way. Even though they feel better after breathing, their HRV do not improve much.

5.4 Problems of User Experience

Gathered all information about user experience, problems can be found as following:

1. Most of them do not like cables and the electrodes. It is a complex system to them. And also tape is very uncomfortable even though they have been told that it is only an experiment.
2. Following the sine-like sample wave is not a big problem for everyone in the experiment. They just slow down the respiration frequency, only the very low frequency breathing need to

be adapted at the beginning.

3. To those failed staffs, they found it hard to breathe in an abdominal way, and it even made them nervous. A limited behavior disrupts their natural behaviors.

If they do not start correctly, all following actions are out of control. Even to those succeeded staffs, the beginning is a little uncomfortable.

4. They say that the sample wave is not bad, but long-term focusing on it is boring and tiresome.

5.4.1 User Journey Map

User Journey mapping is one of the best ways to understand user experience whatever on a product or a service system through visual thinking. Above experiment provide much feedback from HRV-breathing trainees. The experiences of these 18 trainees can be described very differently. There are approximately 20% trainees who failed in the experiment. The other 80% trainees succeed and increased their HRV to relax. These are two different journey maps as follows:

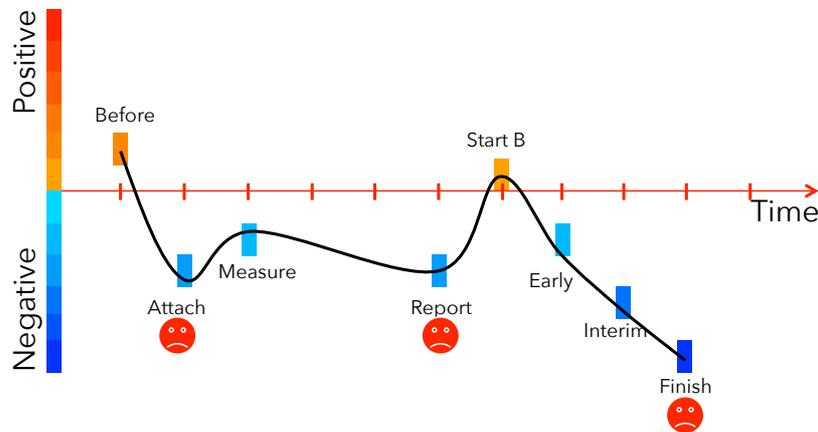


Figure 5.7 Failed User Journey Map

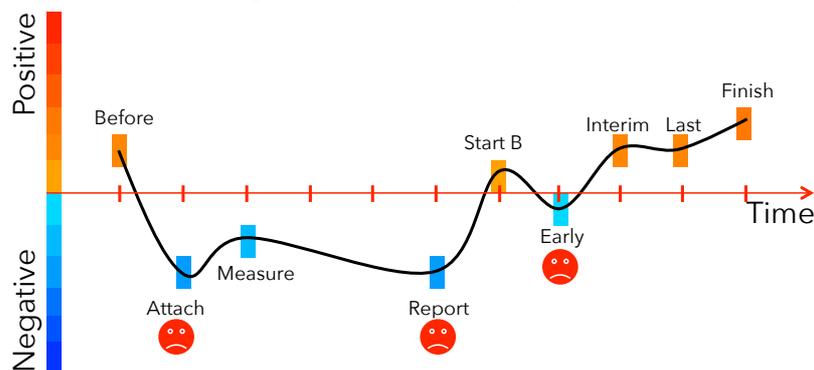


Figure 5.8 Succeeded User Journey Map

Even though, these two different journey maps show that the trainees have completely different results, they all have similar experiences at the beginning. Before they start this training, they are going to know their stress level and will be treated by doing something, the new instrument, new experience, all above is curious to them. The attaching step is marked as a pain point, on which this step gives user very bad experience. Cables, the electrodes, tapes at times and complex attaching process, all make this new treating process clumsy in the beginning. On these maps, the horizontal axis is time. It can be found that the time from measurement to report is long. In most tests or measurements, people do not like waiting for a longtime. It usually increases their nervous emotion. They prefer a quick response. In clinical tests or measurements, results usually cannot be pleasant. Reading a report is one of the sad moments in the whole journey. In this case, the sadness may from the irregular HRV wave

looked uneven. Next, training is coming, which means stress is able to leave. That is a hopeful point for every trainee.

Till now, whether people were managing this training well or not, they had the same experience. Differences are going to happen next. Abdominal breathing skill is hard to follow to the failed trainees and a bit easier to the others. Actually, in the beginning, the unnatural breathing way is unfamiliar to everybody. More trainees can adapt to it but a few cannot. That is why the start point is also marked as a pain point. Next, for those succeeded trainees, breathing goes smoothly, they benefit from the lower frequency deep breathing becoming more and more comfortable. Finally, they achieve the goal to be calm. Only one problem, the training time is usually about 5 minutes even more at times. It depends on how the trainee's breathing acts. In this case, sample wave is just an endless normal sine-like wave, which means that long-time focusing on that boring graph has not much fun. Somewhat it influences trainees' satisfaction to this training. That is why in the journey map, the finish point is still not positive enough even those people have succeeded.

Because the conscious breathing is limited behavior, people who failed during the process feel bad. As we have discussed before the difficult start could be the beginning of the sad journey. They try to follow but find it difficult to, and feel setback and eventually they give up. That is the most painful point in this journey map. Is the abdominal breathing so hard to do? The answer is no. Same answer is from failed trainee as well. What causes the bad experience? Some people do not like being limited whatever thinking or behavior. That conscious behavior makes them uncomfortable, which is the fundamental reason of the failed training.

5.5 Conclusion

All pain points mentioned above indicate that people feel Complicated, Tired, Uncomfortable and limited in their HRV-based on abdominal breathing experience. Therefore, a product problem can be defined as a target in the product-developing work. The HRV and conscious breathing combined training experience need to be improved through product development. The task in following work is:

To design a HRV biofeedback-based on product that can lift mood of stressed people through a pleasant user experience.

6. Market Analysis

As discussed at the beginning of this thesis, two criteria are the most important points in this project. One of them is that the solution should bring opportunities to JOINTECH. Analyses in this phase use some marketing methods to make product strategies for JOINTECH.

6.1 Method

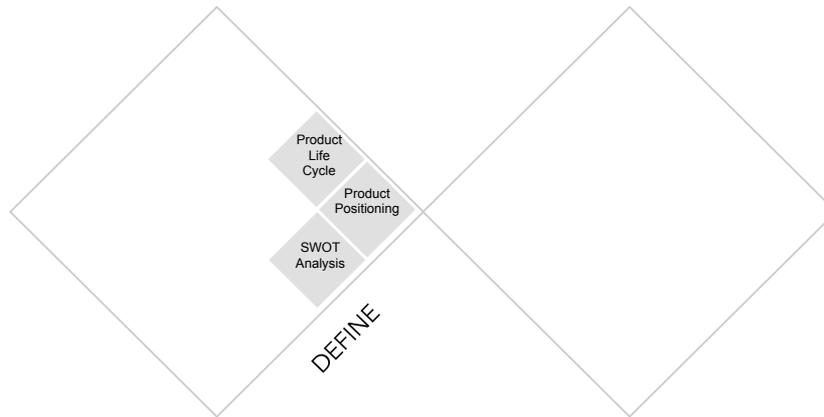


Figure 6.1 Method in Market Analysis

Two methods, Product Life Cycle and S.W.O.T analysis, which are the typical marketing research methods are used in this phase. They are used to analyze market situation, competitiveness of JOINTECH, and their opportunities. These marketing factors influence a product definition as much as all other factors that we have talked before. In terms of product life cycle, products in different life stage have different features because of different market environments. As well, companies with different strengths and weaknesses have their own opportunities and threats. These marketing analyses help companies to make proper product strategies. In product positioning analysis, selecting right product features as parameters in positioning is the most important point. It helps to make product boundaries in the next developing.

6.2 Product Life Cycle

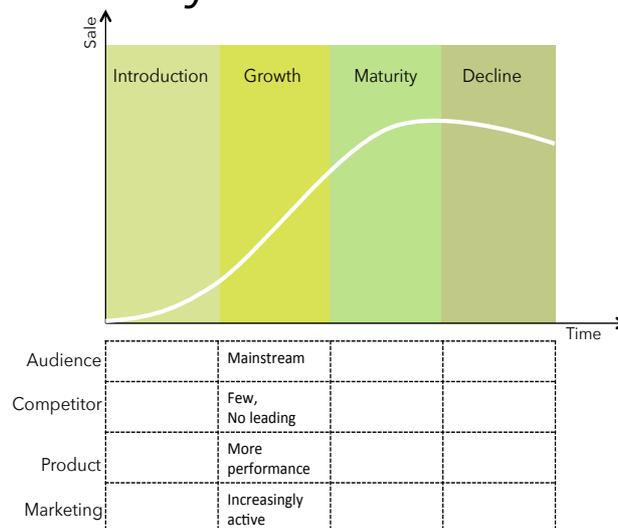


Figure 6.2 Product Life Cycle

According to the theory of Product Life Cycle, ICT-based on health care market in consumer products is in the growth stage, particularly the wearable products for the masses. In this stage, some characters can be found: mainstream becomes the audiences, market is in increasingly active situation, more new entrants than that in introduction stage, also more product performance in this stage. But the competition is not heavy regardless in product amount or product style. And there is no leading contenders appear in this stage. To all companies in growth stage, the most important task is to maximize their market share. Companies with different strengths and weaknesses have their own strategies in detail. In terms of JOINTECH, strategies are going to figure out after S.W.O.T analysis.

6.3 S.W.O.T Analysis



Figure 6.3 S.W.O.T

In S.W.O.T analysis, strengths to JOINTECH are from their background----Product design. Capacities in innovation are marked as the main competitiveness. With the development of this company, they are more and more experienced in product R & D. It makes their innovation in a wider range. As a technology-based on enterprise, marketing is obviously one of their weaknesses. They usually increase this skill through the collaboration with other strong-marketing skill partners. And in health care market, JOINTECH is a new entrant, as same as many entrant companies in the growth stage. Health care is a resources highly integrated market and any new entrant should have its tricks to achieve the goal as soon as possible. In addition, the external environment brings some threats as well. For example, in the rapid growing, health care market must be strongly regulated by government. High access requirements and stricter standards are the possible coming regulations in the near future. At the same time, resources are possible to be concentrated.

What are the opportunities to JOINTECH in this stage? It can be found, current products in this market approach to homogenization. There are still many possible new market segments. Matching with the strengths of JOINTECN, different product performance and differentiation in product service can be good chance to them to maximize their market share.

6.4 Product Positioning

According to the above analysis, JOINTECH is in a situation with good chance but some challenges. The product positioning has been involved in three factors.

What is the New Possible Market?

As the following chart shows, HRV-based on products usually measure the heart rate to get peoples' HRV level, then provide breathing coaching to improve their HRV. If we divide the current products into groups in functions, most products have functions of measuring and coaching. People get to know their stress level only after measurement and the behavior of measurement completely depends on their awareness.

In the function point of view, these products are very optional. Even if there are peoples who really want to get help from these products, it is possible to be forgotten in their busy life. In order to help people and also push the development of HRV-based on products, the measurement is better to keep working all the time. It makes people always in monitoring. When there is an abnormal signal read by sensor, the HRV feedback is able to give a warning to people. This tracking function can be an opportunity on new product.

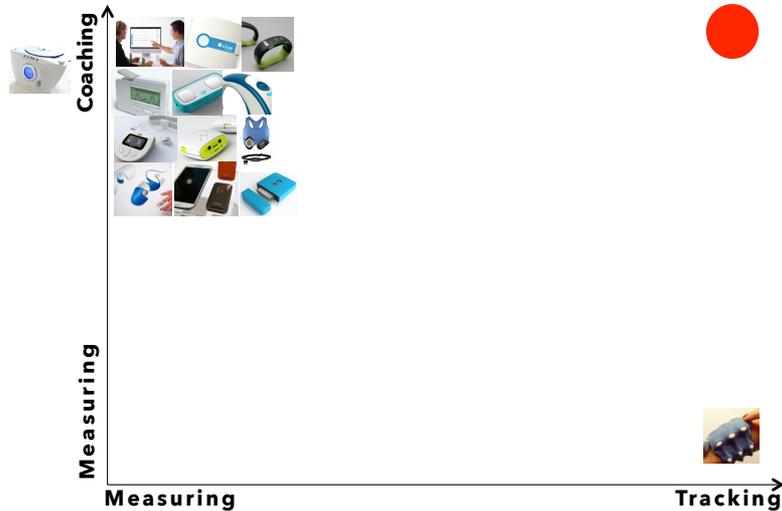


Figure 6.4 Product Positioning1

What the Extension Service Can We Provide?

In ICT era, the definition of product is going to a sequence services. Being based on diverse technical tools, services of stress releasing can be a health care platform but a single product. In the current market, some products are still single functional. Some products are able to provide extension services. They may work together with the computer or the smart phone. However, they just have this possibility. The reality asks for further work in creating a bigger system in internet..

As JOINTECH health care platform is already running, they have more chance to create extension service like remote consulting.



Figure 6.5 Product Positioning2

How to Reduce Risks from External Threats?

Even though, the JOINTECH has established collaboration with other partners, the potential market change has to be considered. Considering the probably coming regulations and

standards, the future of the health care platform is going to shift to a social service-functional platform but medical-functional platform. It meets their strengths and is for the consideration of the market risks.

Therefore, products working on this platform should be customer-featured for preventing disease. There will be more products are positioned in these features. They are all potential competitors to JOINTECH.

In this situation, the great user experience is the key point in the competition.

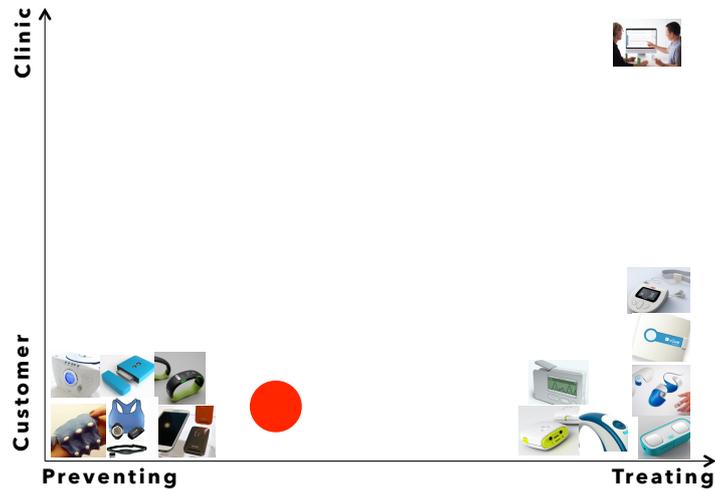


Figure 6.6 Product Positioning3

6.5 Product Strategy

In the growth product stage, as a new entrant, JOINTECH can use differentiation of product, extension services and better user experiences to obtain more consumer market share.

7. Product Development

Health Care Platform

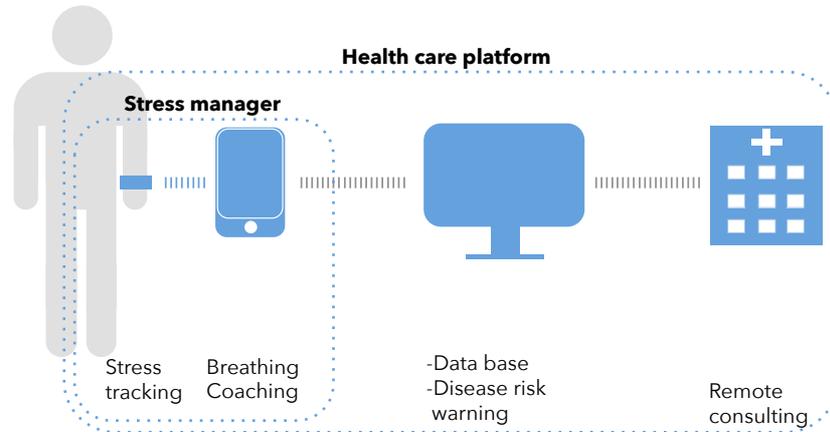


Figure 7.1 Health Care Platform for Sub-Healthy People

The above chart explains that the stress management system can be realized working on an ICT-based on platform. It consists of three parts: the stress manager, the service center and the linked medical institutions or social institutions. The stress manager is the main part of this platform. It provides stress tracking and breathing coaching to users through a wearable sensor on wrist working together with the smart phone. The service center is built on a powerful database, which manages information from users and send warning when users are at risks. It is also a data exchange center to supply remote consulting. As the core of this platform, the development of this stress manager is going to the main work in this chapter. It is also the part concentrating the product innovation, the great user experience and the differentiation of products.

In this wearable sensor and smart phone consisted conceptual product, these two structures are going to work together to provide stress tracking and breathing training, Firstly, the technology process is going to be discussed on how they work well. Secondly, user interface can be found as the most important phase in this chapter. A wearable product seems like the second skin of wearers to communicate with environment. Any feedback between the wearable products and wearers is the crucial value to wearers. Whether the user interface well designed or not is the important determination on quality of the product. Thirdly, in terms of the product performance, esthetics-related issues are going to be discussed.

7.1 Method

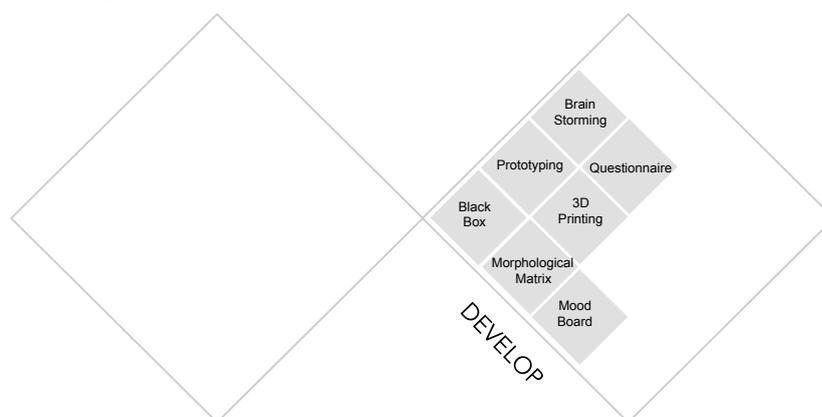


Figure 7.2 Method in Conceptual Product Development

This development chapter includes the most used methods in this project. Black box helps to build the technology system. Morphological Matrix helps to figure out functions of this conceptual product and to evaluate different concepts. In the development process, the tests on ergonomics and esthetics are still needed to do again and again to improve the initial idea. 3D printing is a quick way to get better quality prototype. Prototyping on it can be closer to the real product test. It allows designers to determine how far this prototype is from the one expected. Outcomes of esthetics require deeper study on the requirements of the potential users. Besides those analyzing tools, the direct feedback from the target users is a good way to get to know them well. In color study, questionnaire is used to collect data of users' color preference.

7.2 Technology System

The technology system in this product can be divided into two sub-systems. One is the tracking system and another one is the training system. They work together in a time in different functions.

7.2.1 Tracking System

Black Box

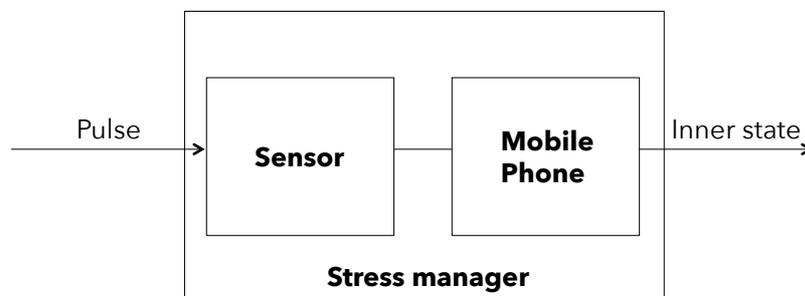


Figure 7.3 Black Box of Tracking System

Black box of the tracking system can be explained as figure7.3. In put pulse and out put people's inner state. Both of two structures involve in this technology process as the following described in detail.

Technology Process

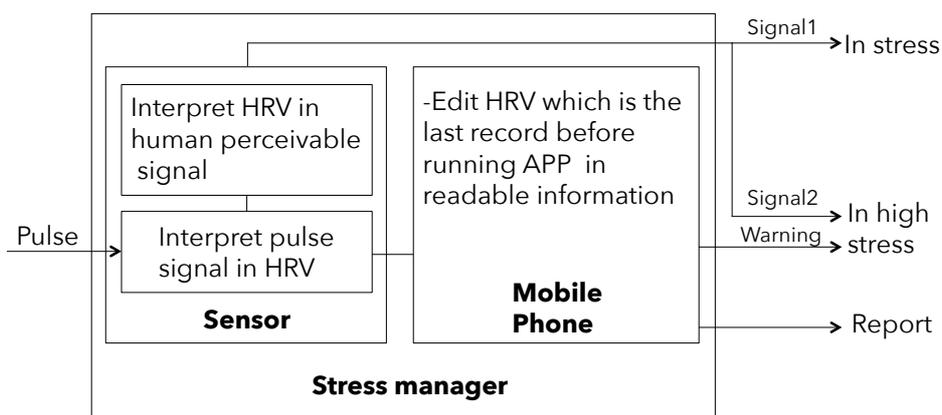


Figure 7.4 Technology Process of Tracking System

HRV feedback is the core technology in this technology system. What kind of feedbacks can wearers get is the most important design point. In the tracking process, there are 2 signals given on wearable sensor depending on different stress levels, and 2 feedbacks given on smart phone depending on different operations.

Pulse in put through the pulse sensor on wrist. Then the signal is interpreted in HRV index by the software in HRV chip through algorithms. Then HRV is interpreted in some human

perceivable signals. They are the output of the tracking system on wearable sensor. One signal gives the wearer a feedback that he/she is in stress but not much. Another signal is stronger, which means that the wearer is in high stress and has to relax. The strong human perceivable signal is transferred in a warning to smart phone. The warning is as well a trigger to initiate the breathing training on smart phone.

Besides the warning, another output on smart phone is a report. The wearable sensor transfers the HRV signal to smart phone through the wireless protocol. This transfer does not always work. It starts only when the wearer runs the installed APP on the smart phone. And transferred signal is the last record on the wearable sensor before the APP running. The signal is edited on smart phone in some readable information, like a checking up report. Therefore, during this process, running the APP installed on smart phone is like a crucial trigger to start the wireless transferring.

7.2.2 Training System

Black Box

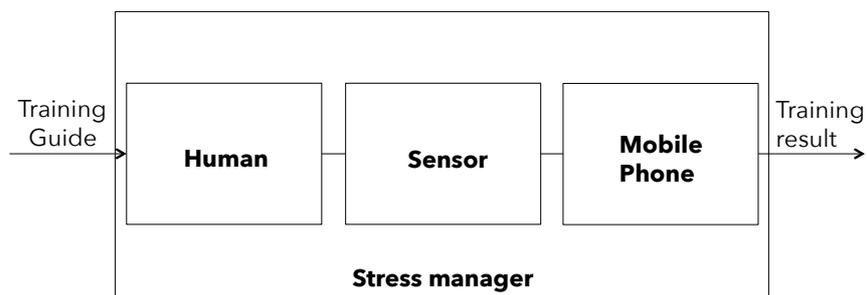


Figure 7.5 Black Box of Training System

The training system is another collaborative work between the human, the wearable sensor and smart phone. As the black box explains, in put the breathing training guide and out put the training result through the human breathing, the sensor tracking and the smart phone guiding. This technology process is a little more complex since the human joined in.

Technology Process

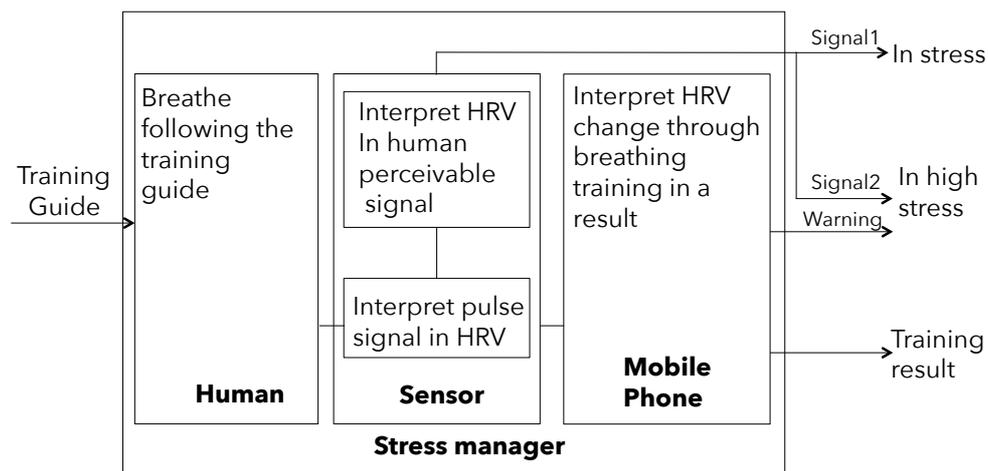


Figure 7.6 Technology Process of Training System

The training guide can be a game, music or an animation. It can be initiated by two triggers in different operations. One is the warning from wearable sensor because of a strong HRV feedback. Another one is the beginning of APP when the wearer starts to run it on smart phone. In put the training guide, the trainee starts to do the conscious breathing. Next steps of the process are almost as same as the tracking process. Only the training result on the smart phone is given in different way.

Engineering Concept

Function		Concept 1	Concept 2	Concept 3
1	Wear sensor on wrist	Band	Bracelet	Bracelet
2	Fix the position of electrode	Close-spaced technique	Close-spaced technique	Close-spaced technique
3	Power on	Touch key	Physical button	Physical button
4	Interpret HRV	HRV chip	HRV chip	HRV chip
5	HRV code transmission	Bluetooth	Low Energy Bluetooth	Low Energy Bluetooth
6	Decode and visualization	HRV chip	HRV chip	HRV chip

Figure 7.9 Engineering Concepts

7.2.5 Engineering Concept Evaluation

There are four parameters with different priorities in this evaluation. In a wearable design case, ergonomics, which can be described as comfort, is the most important parameter in concept evaluation. In order to control the wearable sensor in a proper size, components should be small and good energy efficiency. The final parameter is about feasibility. Engineering solution should accord the production rules. All the parameters in the evaluation are listed in the following chart:

Item		Concept 1	Concept 2	Concept 3
Comfort	35%	7	6	6
Size	25%	5	6	7
Energy efficiency	30%	7	7	7
Production	10%	4	6	6
Sum		6.2	6.35	6.6

Figure 7.10 Engineering Concept Evaluations

Rating

1---10: bad---good

As the evaluation result shows, concept 3 is better than other two because of the better energy efficiency. Thus, in the following developing work, the wearable sensor is going to be a bracelet with the physical button. And the Low Energy Bluetooth is suggested as the wireless transmission protocol.

7.3 User Interface

With the development of wearable technology, an understanding about wearable technology is increasingly coming to our mind. A wearable product seems like the second skin of the wearers to communicate them with the environment. Any feedback between the wearable products and the wearers is the crucial value to the wearers. With the development of technology, the communication between them is not going to be limited in sense of sight and sense of hearing. Other senses like tactual sense, sense of nose and sense of taste can be introduced in wearable products. In this project, the user interface study is broadened to communication ways between the wearers and the wearable products and other involving objects, for example smart phone. I try to break the conventional boundaries to find a natural and pleasant communication between the products and the users.

7.3.1 Users' Pain Points

Firstly, there are some problems about user experience figured out in the experiment before. During the whole process, the HRV sensor and the stressed people do not communicate well. Let us review the user pain points figured out from the user journey mapping: Complicated, Tired, Uncomfortable and Limited.

They can be visualized in the following pictures:



Complicated



Tired



Uncomfortable



Limited

Figure 11 Users' Pain Points

People feel complicated about the systems, one direct reason is the clumsy cables, instead of which wireless bracelet can bring simpler wearing experience. As we have described in the technology process, the tracking on wearable bracelet is going to work all the time. It simplifies the communication between the human and the wearable sensor. There is no long any action to start a measurement waiting for few minutes to get the HRV feedback. The inside conditions of the wearers are always in monitoring and signals are given when wearers are in stress.

From the user journey map analysis, we know that the most painful point to the users is how to communicate with the abdominal breathing training guide. People used to do what they do everyday, moreover, breathing is what they do in every second. It is no doubt that the conscious breathing does the people well but it does not communicate the people well. How to make them close to each other in a natural way? How to release the extra limited feeling on people?

7.3.2 Dandelion Story

The human senses are very important to experience the environment and the objects around us. Vision, touch, smell, sound and taste are working correlated with each other. Human exists with his five senses and experiences the life with a multi sensorial way. However, due to the increasing usage of technologies, people have dominantly been using their visual sense rather than others. This creates an important distraction from the real life and leads to a lack of sensorial experience while interacting with technology, which people do very often (*Venere Ferraro, Secil Ugur from Polimi, Italy, Jun 22-25 2011*).

In terms of synesthesia, it is one of our most valuable feelings. It links to the different human senses and objects in the world. When we talk about the difference between the natural breathing and abdominal breathing, exhalation from mouth should be the most different feature. Actually, mouth exhalation is not unfamiliar to people. It is also a natural behavior when people try to make something away by blowing. Try to imagine a picture: Early summer in countryside, dandelion is growing everywhere, some are still in yellow bud, and some are already in bloom. You can almost smell the fragrance. Make a deep breathing and pick a dandelion blowing the floc away. This is the story that we would like to tell.



Figure 7.12 Dandelion Story

Out of this pleasant picture, it is not difficult to find that in these natural behaviors there are different senses involving in. The fragrance touches off a deep inhalation through nose, the dandelion floc stimulates a exhalation through mouth. The sense of nose and the sense of sight collaborate to finish these spontaneous behaviors. People can act the abdominal breathing spontaneously as what they usually do.

The sense of nose is not often used in ICT-based on products. But in this case, user interface through the sense of nose works well in four ways. Firstly, learned from the natural response of human being, the signal being sent to user through the olfaction way in fragrance is a natural trigger to initiate a deep inhalation. The users do not need any forced guidance for example the difficult start in the experiment. Secondly, different from other active cognitions, the sense of nose is a passive cognitive way. It makes the olfactory signal cannot ignore. In this case, it makes the high stress signal reach the users even when they are so busy. Thirdly, in this project, the users need to obtain the abdominal breathing skill and remember it doing whenever and wherever they are stressed. From the biological point of view, the olfaction is different from the other sensory. It reaches cortex without first relaying in the thalamus. The olfactory messages can be relayed to the hippocampus, which is important to the olfactory memory. The fragrance cannot only be a crucial trigger but also a catalyst of memory. lastly, the fragrance makes the measurement result no longer sad and uncomfortable. It gives a pleasant warning when people are in very bad emotions.

7.3.3 Communication Links

The communication links in this HRV-based on stress manager can be figured out from the technical process.

Communication links	Carrier	Indication	HRV	User interface
Power on/off	Sensor	No fault	----	Flashlight blinking fast in blue
Stand by	Sensor	In tracking	----	Flashlight blinking slowly in blue
Wireless pairing	Sensor	Stand by for transmission	----	Flashlight blinking in red

Tracking	Signal 1	Sensor	In stress	20-40	Flashlight blinking fast in yellow
	Signal 2	Sensor	In high stress	<20	1) Fragrance 2) Flashlight blinking faster in yellow in a bigger area
	Warning	Phone	In high stress	<20	Dandelion on any screen
	Report	Phone	APP in running	----	1) Running APP 2) GUI
Training	Signal 1	Sensor	In stress	20-40	Flashlight blinking fast in yellow
	Signal 2	Sensor	In stress	<20	1) Fragrance 2) Flashlight blinking faster in yellow in a bigger area
	Warning	Phone	In high stress	<20	Dandelion overlays any screen
	Training result	Phone	APP in running	----	1) Running APP 2) GUI

Figure 7.13 Communication Links

The trick of this process is the warning on smart phone: a blooming dandelion. It is a kind of bother to high stressed people. It is also the core idea of this conceptual product. Being different from other similar products, breathing training is designed as a forced behavior and an essential step in the whole system process. The dandelion appears on smart phone when a strong signal is given from HRV sensor and it is designed to overlay any screen. In order to remove it, high stressed users have to do the abdominal breathing training in correct way to relax themselves, otherwise it bothers the users all the time.

7.4 Ergonomics

As the most important factor in a wearable product, study on ergonomics more focuses on function realizing and wearing comfort.

7.4.1 Sensitive Area on Wrists

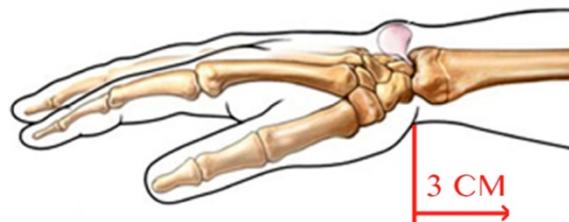


Figure 7.14 Sensitive Area on Wrist-1

According to the ergonomics data (see Figure7.14), the most pulse sensitive area is 3 CM after the bending joint between the hands and the forearm. It is the sensitive point when people perceive by fingers. But for electronic sensor, pulse can be perceived in most area after bending joint to the most sensitive point (See Figure7.15). Theoretically, this is the electrode working area on wrist. The electrodes of HRV sensor are allowed to move in this sensitive area without impact in the working effect.

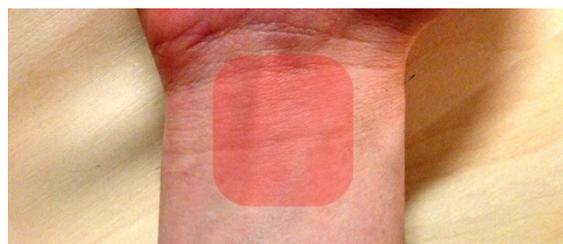


Figure 7.15 Sensitive Area on Wrist-2

7.4.2 Section of Inner Diameter

With the plasticine model, I get different inner diameter sections from women and men. The following pictures are two samples. They are all in 17 CM inner diameter size. The yellow color model is a sample from a woman and green one from a man. It is easy to find that the inner diameter section is closer to round shape from woman, and more flat from man.

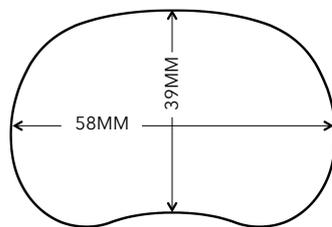


Figure 7.16 Wrist Inner Diameter of Female



Figure 7.17 Wrist Inner Diameter of Male

Because of the different inner diameter section between woman and man, the following section has a camber in the bottom. It adapts to the wrist of woman and man in same size and it matches the natural curvature of the wrist in the pulse-sensitive area. It also helps to fix electrodes of HRV sensor working in sensitive area. This section view is going to be used in the next product development. It fits the wrist size in 17.5 CM perimeter. In production, according to the widely used size reference in bracelets design, there can be 3 size options to users in 15.5 CM, 17.5, and 20.5 CM.



6"	15.3 cm
6 1/4"	15.9 cm
6 1/2"	16.5 cm
6 3/4"	17.2 cm
Bracelet 7"	17.8 cm
7 1/4"	18.4 cm
7 1/2"	19.1 cm
7 3/4"	19.7 cm
8"	20.3 cm
8 1/4"	21 cm
8 1/2"	21.6 cm
8 3/4"	22.2 cm

Figure 7.18 Section of Inner Diameter

7.4.3 Bracelet Structure Test

Another research on bracelet structure is about buckling and fastening. This research focuses on these two structures in most wrist-wearing products, for example watch and bracelets. The following picture collects various buckling and fastening structures and divides into 6 main solutions. The very common buckling solutions on watch are the metal hasp and the belt buckle. The belt buckle is also a good fastening solution widely used on watch and bracelets. It is the very basic buckling and fastening structure for any wrist-wearing products. For instance, it is popular used in wearable electronic products but in different materials. On electronic products, instead of leather, materials for belt are usually silicon for medical products. It has good elasticity and safe. The elasticity of silicon belt is the fastening method as well. Besides, there are some bracelets made from metal have close-space structures, which is both the buckling and fastening method on these products. These products usually have close-space design. The ductility of metal make them deform properly when put them on wrist.



Figure 7.19 Bracelet Structure

In this project, the solution on buckling and fastening is asked for these features: simple, easy in production, easy to use for users and safe. The next chart analyzes the above 6 solutions in these 4 features.

	Simple	Easy in production	Easy to use for users	Safe	Evaluation
Metal hasp	1	1	3	3	8
Belt buckle	3	1	3	4	11
Silicon belt	3	4	3	3	13
Metal ductility	4	3	4	3	14

Figure 7.20 Bracelet Structure Evaluation

Rating

1---5: bad---good

As the chart shows, metal ductility is the simplest solution and very easy to use. The wearers just need one action to put the products on the wrists. But metal structures make some people in allergy. In production, the metal structure can be covered by some other safe material for example silicon and ABS.

This metal and ABS combined solution is going to be the main structure of the wearable sensor in this project. Taking into account both buckling and fastening features, the structure of wearable sensor should be properly tight and easy to wear. The following pictures show the results of a test.

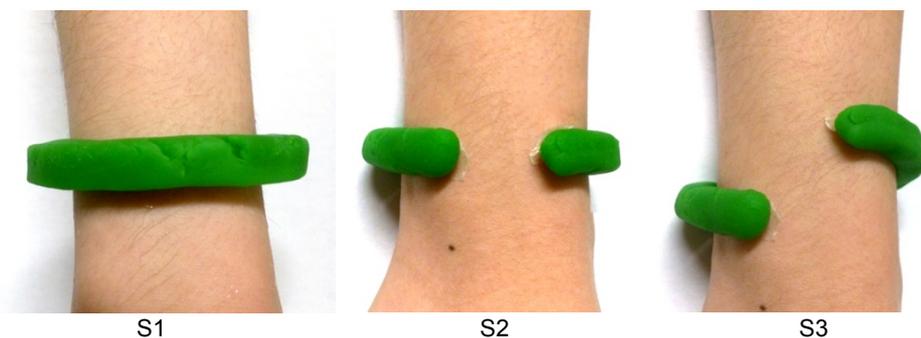


Figure 7. 21 Models for Bracelet Structure

The metal ductility structure can be the above 3 forms. Comparing to other 2 forms, S1 looks more cumbersome. As we have discussed in the chapter 2, the target users have some requirements to life, environment and products. For example, they prefer simple style and inconspicuous decorations. They don't usually run after the conspicuous and prolix design. Comparison between S2 and S3 shows that in same perimeter size, S3 form makes a bigger gap between the ends. It takes an easier way to put the bracelet on.

7.5 Esthetics

The esthetics study is the last stage in product design but the first image to the users. All above studies have to be expressed in a proper way to make the users feel pleasant. In this stage, more work on visual factors makes the conceptual product of the stress management solution complete and dedicate. It can be the most important feature in a product. It is the first communication between the users and the products. Studies in this phase focus on the preference of “white-collar” workers, graphic abstraction, sketches and the model test.

7.5.1 Identity of “White-collar”

The wearable product form embraces aesthetic concerns and the importance of respecting the culture of the end-user (*Venere Ferraro, Secil Ugur from Polimi, Italy, Jun 22-25 2011*). This analysis on identity of the “white-collar” workers does not focus on what they are now, but what they want now and in the future. As we have mentioned before in the second chapter, the “white-collar” workers are a group of people who have busy and whirlwind life but ask for simplicity and relaxation. These demands from heart can be found in their dress, behavior, habits, hobbies and most factors of their life style. In terms of design, they more like laconic style without excessive decoration and delicateness in quality. In particularly, natural materials and colors are their preference (See *Figure 7.22*). These aesthesis closely relate their experience and living environment. And these perceptions reflect their desire, which usually influence their choice in life whatever they are in good circumstances or not.



Figure 7.22 Identity of “White-Collar”

7.5.2 Mood Board

Starting from the dandelion story, NATUTE has become the main topic in this project. The special experiences what we would like to make are the multiple sensorial experiences, natural way of breathing and the relax atmosphere, all of which is made to recall the moment of nature and relaxation.

What is nature? It can be what we feel in the world: fresh air, grass, flowers, a wall, some sands, light and so on. Nature is a state that an object can be because of its characters. As the following pictures shows, there are many shapes and patterns naturally appear on the objects themselves. For example, a rolling rope is in spiral shape; different leaves and stems of plants have different kinds of natural curl; a piece of flower have a slight bending before blooming; a gust of wind brings the undulating surfaces to sands.

In this project, natural spatial form and undulating surface are abstracted and used as design elements in product appearance.



Figure 7.23 Mood Board1

7.5.3 Visualization

With the help of analysis in esthetics, some initial product forms are discussed in using natural patterns and spatial forms. The later is the most difficult part is this process. The very natural spatial form expresses a shape happening in a moment. But the product form is stationary. Shifting the dynamic shape to static form cannot be limited in sketch; therefore, some iterative modeling digitally or physically is essential. In this process, sketch is more focused on pattern such as undulating surfaces, and modeling is more focused on spatial forms.

Color is another important visual element in concept expressing. Color study in this project is also based on the key point—nature, but tries to get more information from target users.

The stress manager in this project is a combined idea that consists of wearable HRV sensor and the smart phone. The process of shifting conscious breathing to natural breathing works on APP that runs on the smart phone. Graphic interface design is going to work with some abstracted natural elements.

Sketch

Undulating surfaces are widely used in different design field, for example architecture design, interior design, fashion design and so on. It is identified as a laconic and modern pattern. Furthermore, it can be a link between nature and artificial things. Some sketches aim to find a good way to express this idea on this small bracelet.

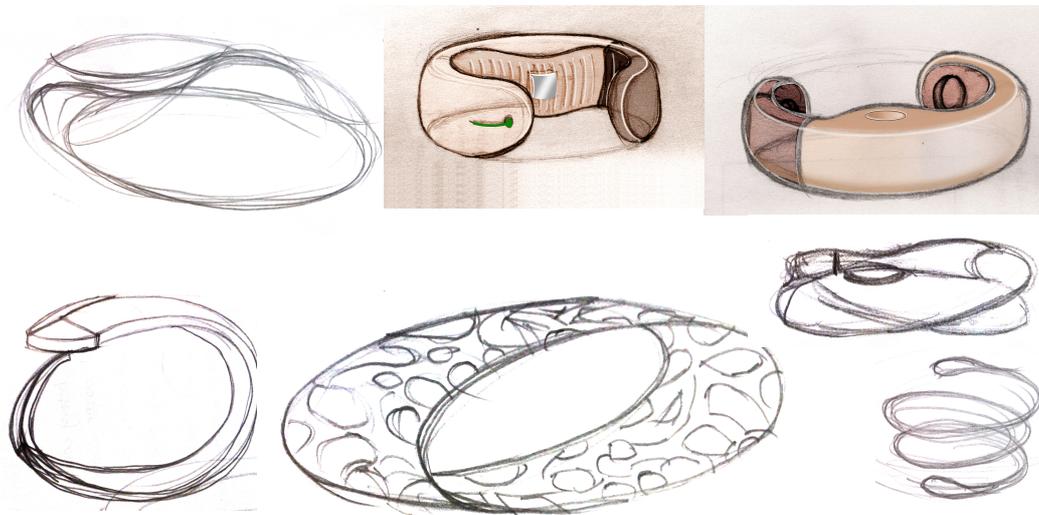


Figure 7.24 Sketch

Plasticine Modeling

In this plasticine modeling, all factors about ergonomics discussed before are considered but more focuses on how to make it natural and elegant. One element is joined in modeling, which is asymmetry. Purpose of asymmetry is to express an extended sense to feature the dynamic form.



Figure 7.25 Plasticine Modeling

Color

Color study in this project consists two parts. One part is the color preference from the study of “white-collar” identity and mood board. Those colors around them are white, gray, brown, black and blue. Except black and white, other colors are usually used in dark or light. Based on these colors, another part in color study is a questionnaire to the target users.

This is an online questionnaire through a social medial. A questionnaire is designed and put on Weixin, which is a quite popular Chinese social medial APP. The communication of Weixin is in specific cycles. It makes a broader question range and makes it work on target users. Only one question is designed as the following screenshot.

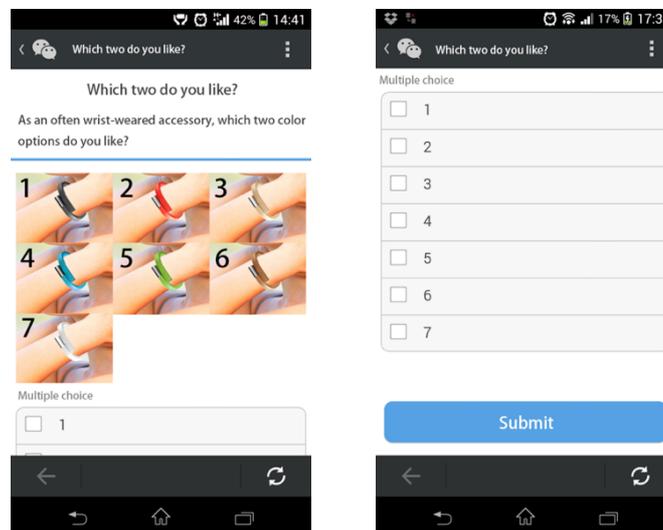


Figure 7.26 Questionnaire APP

Respondents are asking to select two colors that they like most to this product. With this online app, this question spreads quickly and collects 95 answers in one day. There are 7 color options for this kind of wrist-wear accessory: 1—black, 2—red, 3—skin color, 4—blue, 5—green, 6—brown, 7—white.

The results of questionnaire are automatically calculated by this APP.

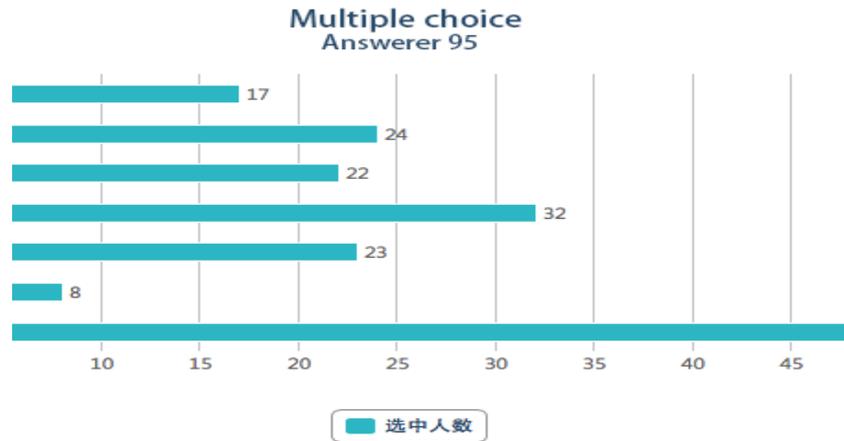


Figure 7.27 Questionnaire Data Collection

From the above chart, it is easy to find that white is the most popular color. There are 49 respondents like white color in a bracelet. And the second popular color is blue in 32. Brown gets the least favor among these color options in only 8. Other 4 color options are around 20. If we select two colors as the final options in this project, they are white and blue.

Graphic Design

In this concept design, there are two parts combined to express the main idea: the wearable sensor and the application installed in smart phone. Graph is an effective way to communicate between products and wearers. Continuing the natural idea, graphic design focuses on both the wearable sensor and the smart phone application.

The Application plays the role of breathing trainer in this stress manager. It communicates with users in visual way through smart phone. It is the part that most expresses the natural breathing idea. Graphic design in this phase is around dandelion. The left picture is a dandelion photo. In order to create a natural feeling in training process, dandelion is not much abstracted. The right picture is the dandelion graph.

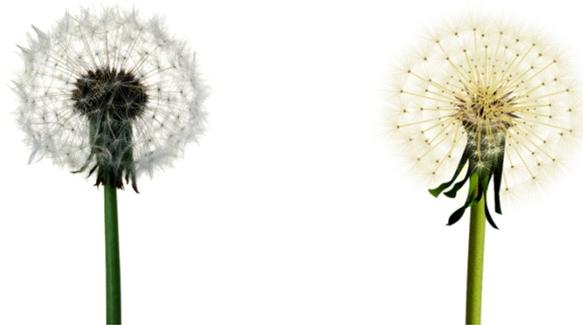


Figure 7.28 Graph1

The following icons are abstracted from a dandelion flower. The left one is going to use in application as a background pattern. The right one is abstracted more and is going to use on wearable sensor as the warning flash.



Figure 7.29 Graph2

7.6 Model Test

After the product development process, there are still some questions out of my mind: How does this bracelet work? Is it comfortable? Does the undulating surface work well on this small stuff? All these questions can be answered by a test with a quick 3D printing mode (See Figure 7.30). These pictures show that there are still many problems on this bracelet idea.

1.The inner shape from the ergonomics study does not fit the wrist shape. And the touch point of electrodes is the most uncomfortable point. Actually, the shape of the wrist is different in individual. This test is conducted on two women and three men. The left-up picture shows how it works on a woman's wrist. There is still some space between the wrist and the bracelet. It makes the bracelet move when the wrist turns up. This bracelet fits one of the men well but fits two women bad. It is difficult to figure out an inner shape that fits everyone well.

2.The spatial curve looks unnatural. The ABS plastic makes the bracelet has a difficult deformation, which leads to difficulties when takes it on wrist.

3.In terms of material, plastic is not a good material for wearable products. It is too hard and difficult to control. Sometimes, it may hurt wearers' skin. This hard stuff presses wrist tightly, which is a kind of limits to wearers.

4.The production process is not as good as expected. The spatial form and very small thickness bring problems in 3D printing. The engineering evaluation from JOINTECH is also negative. It is a big challenge to do the layout in this small line-like model. The model size is not enough for necessary components.



Figure 7.30 3D Printing Model Test

In conclusion, the bracelet idea is failed. It does not really work as expected. The problems of this model are mainly from the hard plastic material. It is very uncomfortable and restrains free deformation. In order to keep the HRV sensor tracking wearers' heart rate, the electrode has to touch skin and only move in the pulse sensitive area. It requires no space between the bracelet and the wrist. From this point of view, hard materials are not good for this kind of wearable product. A further test aims to make it softer and more comfortable (See Figure 7.30, the left down picture). Twining the ABS bracelet with thin cleaning sponge makes it a little softer and more comfortable. This sponge layer also covers some space between the wrist and the bracelet. It seems that some soft materials like sponge, silicon and rubber are able to improve the wearing comfort.

As the wearing comfort is the most important parameter in the evaluation for this concept design, more tests are needed on it to find a relative best solution. Before, in the engineering concept evaluation phase, concept1 with band was assessed as the most comfortable idea.

But considered the production and product size, that band idea was abandoned. In order to find the right solution, a test on band idea is conducted with the leather belt (See Figure 7.31).



Figure 7.31 Leather Belt Test

The leather belt in figure 2 is a quick hand-made model for testing the wearing comfort. The results from this test as follows.

1. It is much more comfortable than any hard stuff even if some is covered with soft materials.
2. It is kind to wearers because that it is the most popular material for wearable stuffs. Wearers never feel any distance between.
3. It does not move much on wrist as expected.
4. As the evaluation from JOINTECH shows, in this leather belt idea, electronic components can be gathered but distributed in the bracelet as before. It is better in production.

After the all tests above, the hard bracelet concept is proved not a good idea. Another concept evaluation is asked to retake as follows.

7.7 Concept Re-evaluation

This concept re-evaluation uses the same parameters as before. The two concepts are compared. Solutions for functions are same between these two concepts, except the function 1—Wear sensor on wrist. Concept 1 has the solution of hard bracelet and concept 2 has the solution of band.

7.7.1 Concept

Function		Concept 1	Concept 2
1	Wear sensor on wrist	Hard bracelet	Band
2	Fix the position of electrode	Close-spaced technique	Close-spaced technique
3	Power on	Touch key	Touch key
4	Interpret HRV	HRV chip	HRV chip
5	HRV code transmission	Low Energy Bluetooth	Low Energy Bluetooth
6	Decode and visualization	HRV chip	HRV chip

Figure 7.32 Concept Re-evaluation1

7.7.2 Concept Re-evaluation

Item		Concept 1	Concept 2
Comfort	35%	8	4
Size	25%	5	5
Energy efficiency	30%	7	7
Production	10%	6	6
Sum		6.75	5.35

Figure 7.33 Concept Re-evaluation2

Rating

1---5: bad---good

In terms of comfort, concept 1 is much better than concept 2. There is not big difference between these two concepts in size and also energy efficiency is same. In production, even though the quality rate of leather belt is more difficult to control than polymer mass production, it is still a common product in production. The line-like small stuff has many problems in production as well. Therefore, in this comparison, concept 1 wins because of the better wearing comfort and goes to the new concept idea of this project.

7.8 Band Concept Development

Most studies before are still useful and they are going to keep in the band concept development. However, as the idea has moved from solid bracelet to leather belt, some phases in ergonomics and esthetics are going to be remade.

7.8.1 Leather Belt Structure (Ergonomics)

In this concept, the structure of the wearable HRV sensor is a main electronic part combined the leather belt. It is similar to a common watch. No matter what the concept is, size of this product is still very sensitive. The advice from JOINTECH is that the minimum thickness of this electronic part can be 8 mm; the minimum layout area can be 5 square centimeters. The width of leather belt can be the very common size both suitable for man and woman in 10 mm. According to these suggested size, an initial structure of this concept is as the following.

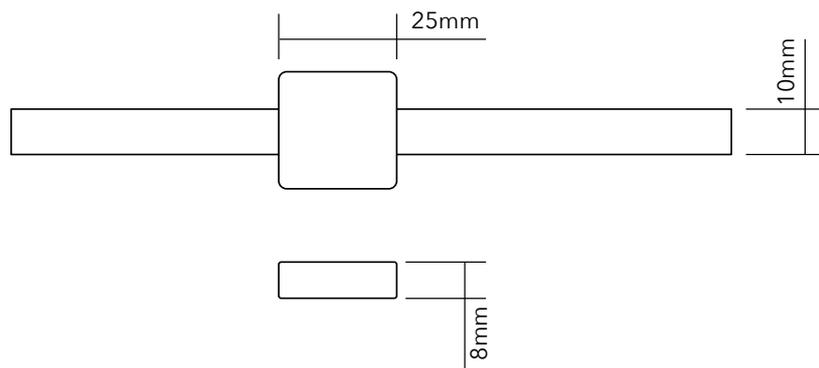


Figure 7.34 Leather Belt Structure1

The leather belt is very popular used both on watches and bracelets. So, there are many solutions on buckling and fastening. As mentioned here, different kinds of buckle are able to work well both on buckling and fastening. What we are going to use in this project is the one highlighted in blue line with simple structure, easy to use and inconspicuous.



Figure 7.35 Leather Belt Structure2

7.8.2 Mood Board (Esthetics)



Figure 7.36 Mood Board2

Mood board here for this concept is very simple. Continuing the idea of going back to the nature, aim of the design is to make this HRV sensor as familiar as possible to a watch or a leather bracelet, then narrow the distance between this wearable sensor and the wearers.

7.8.3 Color (Esthetics)

Usually, the most popular leather colors are the original leather colors such as skin color, brown and black. In this stress-involved project, light original color is better to bring a sense of relaxation.

7.8.4 Graph (Esthetics)

Besides those results figured out in graphic design phase before, one more abstracted graph is used in the design of the main electronic module.

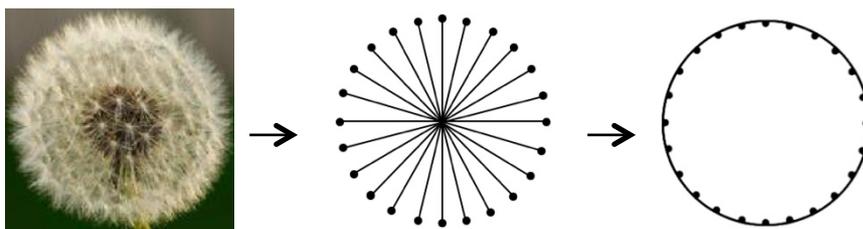


Figure 7.37 Graph3

7.9 Conclusion

Prototyping plays an important role in the studies of the product development. Any initial idea needs tests to improve. Sometimes designers even need to repeat a process from an idea to a complete product solution by different sorts of experiment. Particularly, this kind of wearable products has very close relations with our bodies. It asks for better communications between the wearers and the products. Experiments in this developing process involve in communication technology, ergonomics, material science and esthetics. Different approaches give designers right ways to manage this complex system.

The most valuable experience in this process is that the final concept design is figured out after a failed previous idea. It emphasizes the importance of doing experiments in a right way. Although, prototyping and test is throughout this developing process, some approaches and tools do not work well, for example the plasticine modeling and the computer digital modeling. This wearable product needs tests on our bodies and asks for more tests on materials.

8. Delivery

After the research, experiments, and developments, in this chapter, a complete concept can be delivered. It includes the appearance of the wearable sensor, usage, application, scenario, engineering and materials. As an ICT based on solution, it consists of many parts and it provides a new experience to the wearers. The most attention in this chapter is to deliver a story from being in stress to being inside balance. In this story, the relations between each part are going to clearer as well.

8.1 Method

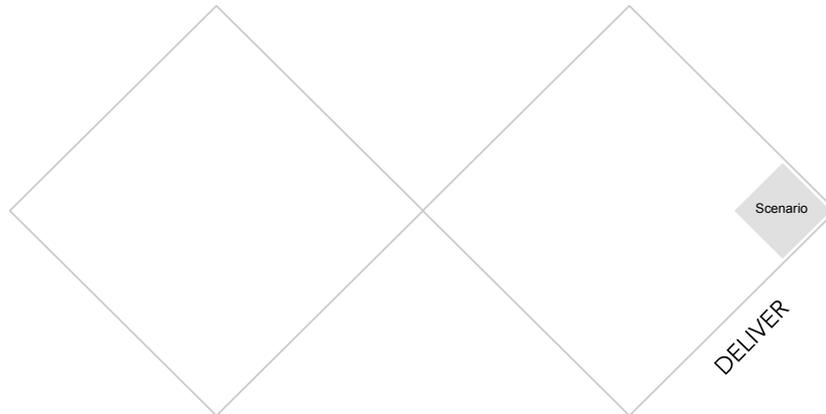


Figure 8.1 Methods in Deliver

Scenarios are stories of a future situation or process. By creating a concrete story about a potential future, scenario helps create shared understanding and enable meaningful discussion. It aims to describe a use case of a particular service in development, and to create a future vision based on important drivers to support decision-making (Ursula Davies, Kelly Wilson from Design Council, the United Kingdom). In this deliver chapter, it helps to describe this ICT-based on system and the idea of going back to the nature.

8.2 Product Appearance



Figure 8.2 Product Appearance

8.3 Usage

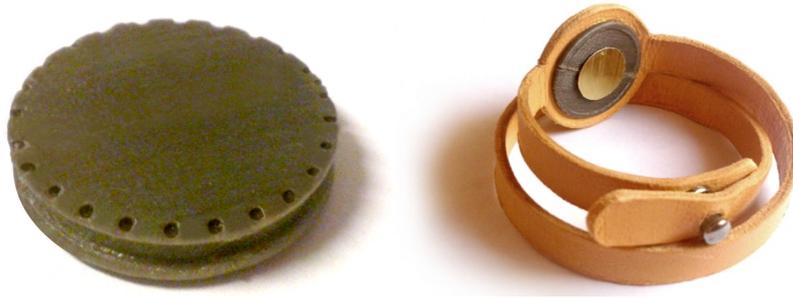


Figure 8.3 Product Usage1

As we have discussed before, HRV sensor works on the wrist, ears, chest and fingers. It measures pulse to get heart rate variability. In order to provide a flexible way to users, a modular design on this HRV sensor consists of a main electronic module (See Figure 8.3) and three leather accessories. All electronic components are designed in this round module such as the battery, HRV chip, USB connection and so on. It can be taken off from the leather belt. This modular design provides different kinds of usage in different circumstances.

Bracelet



Figure 8.4 Product Usage2

With the wrist belt, the sensor can be taken on the wrist, the electronic sensor module is inside the wrist and the outside is a leather decoration.

Attach It to the Watch Belt



Figure 8.5 Product Usage3

Sometimes, the users have already taken their watch on the wrists. They don't like much stuff there. This accessory can be attached to the watch belt inside of the wrist. Particularly, the "white-collar" workers prefer the way of inconspicuousness.

Pendant



Figure 8.6 Product Usage4

In winter, it is possible to take it on as a necklace. Clothes are helpful to keep it on skin of the chest.

8.4 APP & Scenario

Application installed in smart phone is another important part of this project. It includes the crucial point in breathing training. It works together with the wearable sensor. As they are physically separated, the whole experience to the users should be a kind of story, in which phases should be linked logically and emotionally. In this phase, firstly, the application is going to be discussed. Secondly, a scenario is going to describe how the whole process is going.

8.4.1 APP

The graphic user interface design is going to follow the natural style and dandelion idea. It aims to make the practice process comfortable and kind to users.

Some rules are used in this application design.

1. The graphic user interface should be pleasant and kind. Some natural elements associated open air and plants are used in design. For example the dandelion abstracted graph and a flying bee. It aims to make an atmosphere of being back to the nature.

2. The feedback should be clear, useful and kind. This application is a five pages simple APP. It links to the database of the health care platform. Thus it can be simple and only provide necessary information to users and gives them a fast feedback. Although aim of this project is to change conscious breathing practice into natural behavior, users at the beginning still need to be guided. Therefore a sinusoidal moves with the flying bee under the dandelion. The beginners are able to learn how to control there breathing in abdominal breathing by following the movement of the flying bee.

3. The information should be given properly. There are much data can be gotten from HRV measurement. Here in this project, only the most relative data is given in two layers. The first layer, as users more care about there inside condition, the application gives them a direct result whether they are in balance or not. For example, an office lady gets a warning from the HRV sensor that she is in stress. At that moment, if she runs the application, she can find that she may be in tense. Furthermore, more clinic data in detail is given on the second layer when the users press the DATA. If the users need more data, besides going ahead to HISTORY page, they are able to ask for from the database.

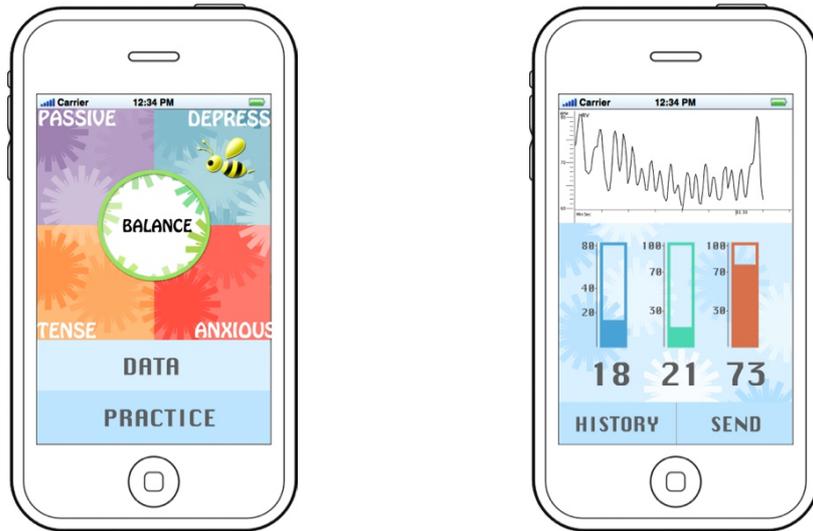


Figure 8.7 Graphic User Interface1



Figure 8.8 Graphic User Interface2

8.4.2 Scenario

Stressors are called in psychology science as the causes that make people stressed. There are many different stressors in our life. For instance, business competitions, working pressure traffic jam and so on. Firstly, when we are high stressed, particularly in the extreme moment, those natural responses are helpful and we can behave some, for example shouting alone and tearing papers even taking off clothes. After that, we may feel calm, but it is not really calm. That is why people need doing more in a right way to make themselves in real inside balance. After the natural responses, the HRV may be still at a low level between 20-40; and the HRV curve is in disorder. The wearable sensor gives a slight warning in an orange color flash dot on top of the sensor module. This orange dot flashes in a faster rhythm to catch wearers' focus. If the HRV of wearers is lower than 20, the wearable sensor gives a strong warning in an orange bigger circle. At the same time it releases the fragrance. At this high stressed level, a dandelion blooms and overlays partly any screen in the smart phone. This is also the right time to do the abdominal breathing. The users just breathe slowly like blowing the dandelion away as usual. Later, the dandelion on the screens is going to flying away with the HRV going up until it goes above 20.

There is another parallel system in the smart phone. When the wearers run the application, the first page gives the result of inside state. Going ahead to the data page, the wearers get the data of HRV, the High frequency and the Low frequency. Wearers are able to continue checking history or send this report to health care platform to ask for remote consulting. If the

wearers want to practice breathing whenever and wherever they are, going ahead from the first page to the practice page, the wearers also can find a blooming dandelion on it, and a sinusoidal down to guide beginners.

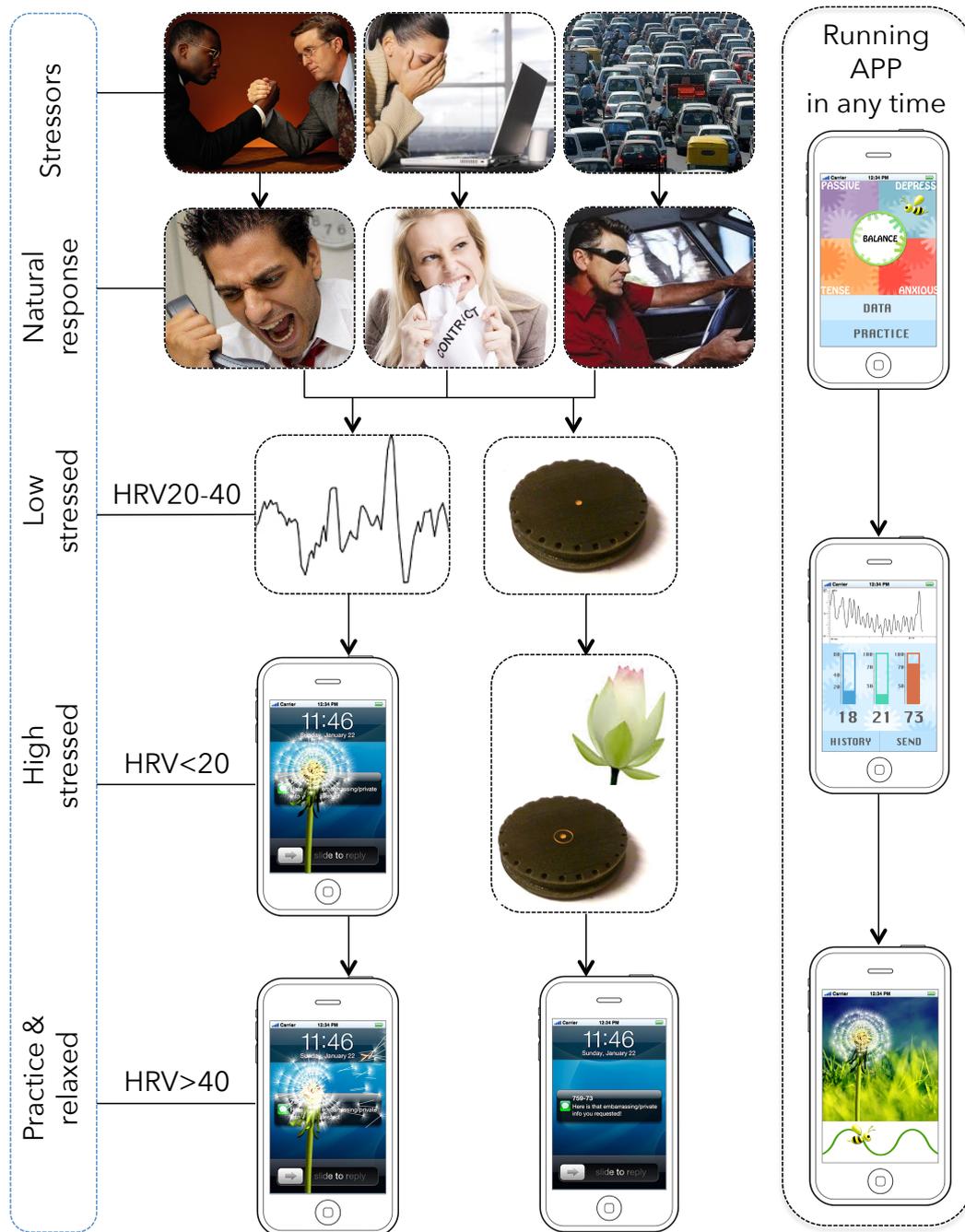


Figure 8.9 Scenario

8.5 Engineering

As the delimitations mentioned in the first chapter, the engineering study in this project is not going deep. What the JOINTECH Company asks is a basic solution and makes it feasible. The engineering study in this concept design is going to explain the basic structure of the main electronic module including the cover parts and the PCB layout, then to describe the principle of the fragrance device. It is a special part in this product, which is usually used in electronic cigarettes.

8.5.1 Cover Parts

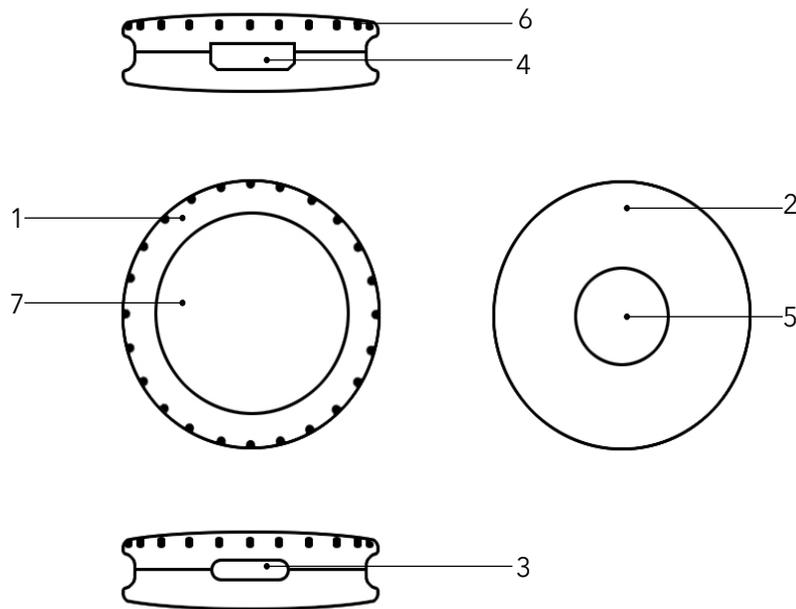


Figure 8.10 Cover Part

- 1— Upper cover
- 2— Under cover
- 3— Power on/off button
- 4— Micro USB
- 5— Electrode
- 6— Holes for fragrance
- 7— Cover of fragrance device

8.5.2 PCB Layout

As a concept design, there are not many limits from JOINTECH in engineering or production. Because there are some components firstly used in this conceptual product for example the part for fragrance. This engineering solution needs further test in the next developing process. In this project, it is asked to be feasible theoretically.

It is a double-side PCB layout. The main components on the upper side are the fragrance device, which consists of atomizing and liquid container—2,3. Another user interface component LED is in the center of this upper side. On the edge of PCB board, the power on/off button can be seen also from the upper side. Because the upper side is the one that faces to the users, most components about user interface are in this side. On the contrary, most components that work on measuring are in the under side stacked. Lithium battery is the biggest one in the center. The inner electrode stacks on battery. The HRV chip is a small component that is next to the battery. Because the Micro USB is in a relatively big size in this module, it is partly embedded in PCB on the opposite edge of the power on/off button.

This PCB layout is explained visually as the following picture. Theoretically, it is feasible, but it still needs many tests in future the developing work.

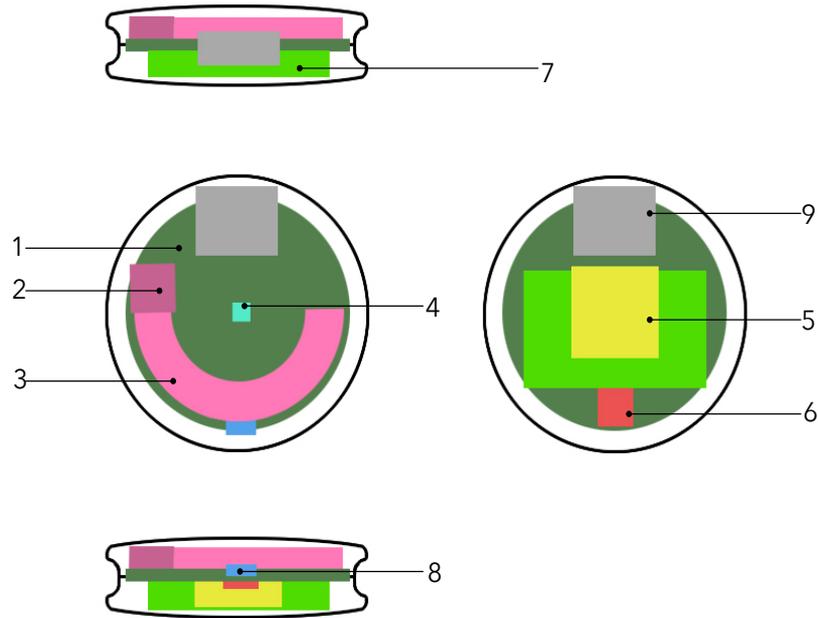


Figure 8.11 PCB Layout

- 1— PCB
- 2— Atomizing
- 3— Liquid container
- 4— LED
- 5— Electrode
- 6— HRV chip
- 7— Lithium battery
- 8— Button
- 9— Micro USB

8.5.3 Principle of Fragrance Device

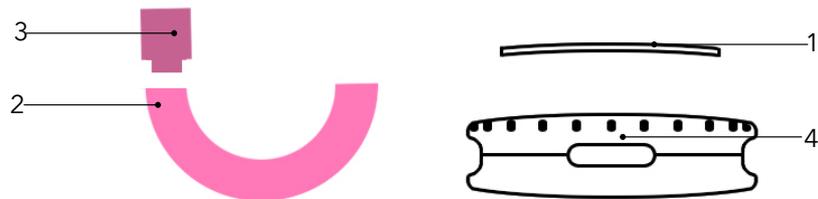


Figure 8.12 Principle of Fragrance Device

- 1— Cover of the fragrance device
- 2— Liquid container
- 3— Atomizing device
- 4— Main covers

The principle of the fragrance device is similar to the atomizing device in the electronic cigarette. The No.2 is a liquid container, in which liquid perfume is heated by the No.3--atomizing device. Both of these two parts are assembled and put into the main covers of the module. The liquid container is removable by removing the cover of the fragrance device. After a few time using, the liquid can be re-injected by professional people.

8.6 Materials



Figure 8.13 Materials

In this modular design, all accessories are made from good quality full grain leather and in natural skin color. Thickness of the leather is recommended in 2 mm to make it strong and durable, also exquisite.

The electronic module is made from PC+ABS polymer. This material combined the advantages of PC and ABS. PC has good mechanical properties, for example good thermal performance, impact resistance and the corrosion resistance. Particularly, the corrosion resistance is important because of the fragrance-involving device. Then, ABS is one of the best materials with good property in toughness. This PC+ABS polymer is increasingly popular in mass production of medical products.

9. Future Development

In the future, this conceptual product is going to develop further in the JOINTECH Company

1. Market evaluation is going to do. It will focus on the potential opportunity and details about the potential opportunities, such as proposals of getting opportunities, value of opportunities, and so on. In a real business, this market evaluation is made as the first task in the future development.

2. Technology people in JOINTECH are going to evaluate the feasibility in engineering. For example the fragrance device has never been used in ICT-based on products. The relations between this component and other electronic components, particularly the relation with RF components may influence the whole system.

3. The core innovative idea—blowing dandelion through APP in smart phone also needs some tests. The key test point in APP is the sensitivity of HRV sensor. It should match the user interface requirement, for example the feedback time. An application is going to design in the next development stage but simple.

4. Make a simple working sample. It will be used to do a real test on stress measurement and breathing practice.

10. Conclusion

In the Introduction, aims of this study include three points: create a value for sub-health people; learn to manage knowledge from different fields in product design process; study design approaches used in wearable product design.

Outcomes for the defined problem are practically proved helpful to people when they are in stress. Outcomes theoretically create a pleasant user experience. The aim about solving a sub health related problem is achieved. But in terms of a product, there are more work on tests and evaluations in the future development.

In this process, some personal experiences and thoughts are as follows:

1. For an ICT-based on wearable product design, it is not just in terms of fit but how the wearable products affect the body's ability to function. To fully understand the needs of the end-user, a designer should have some knowledge of human movement and of human physiology (*Venere Ferraro, Secil Ugur from Polimi, Italy, Jun 22-25 2011*).
2. This is an ICT and health care combined project that focuses on designing a product solution for sub-health people. It involves biology, psychology, information and communication technology, material science, esthetics, ergonomics, marketing and so on. Approaches from different fields are helpful and needed. A designer should select proper tools and use them to manage different sorts of knowledge.
3. There can be more possibilities in wearable products. A designer should try with different results of technology development to find innovative idea. For example, in the report from IBM (*«IBM 5 in 5»*), a prediction is that in 5 years in the future, development of ICT is going to Cognitive system time. Products at that time may learn, adapt and feel the world around people. It may be as same as human being with different senses. In the future, an individual may take nature with him instead of going there physically.

To sum up, the aim of this project is to create a balance. This balance in sub health term is an inside balance for people who are stressed. This balance in wearable product design is a balance between technology and nature. With the development of technology and science, more and more new solutions and methods can benefit our life but not all of them can be really enjoyable for people. The aim of wearable study is trying to use designed technology to link the human body to the nature.

List of Figures

- Figure 1.1 JOINTECH Health Care Service Platform
- Figure 1.2 “Double Diamond” Model
- Figure 2.1 Fukuda complete text of revised case definition (*CDC*) in 1994
- Figure 3.1 Methods in Research
- Figure 3.2 Target users
- Figure 3.3 Interviewees’ Personal Information
- Figure 3.4. Question list to Interviewees
- Figure 3.5 Functional Screening and Computer-assisted Diagnosis
- Figure 3.6 Self-generated Physiological Coherence System
- Figure 3.7 GIGA map
- Figure 3.8 the stress-Illness Relationship
- Figure 3.9. Stress Management System
- Figure 4.1 Method in DEFINE Phase
- Figure 4.2. Stress-related Solutions in Current Market
- Figure 4.3 Physiological Responses
- Figure 4.4 Physiological Response & Biofeedback
- Figure 4.5 Biofeedback Solution Analyses
- Figure 4.6 Heart Rate Variability
- Figure 4.7 Figures of Heart Rate, MEAN and HRV From a Test
- Figure 4.8 HRV and Emotion
- Figure 4.9 HRV Index
- Figure 4.10 HRV & Age, Gender
- Figure 4.11 HRV Index
- Figure 4.12 Breathing & ANS
- Figure 4.13 Breathing & ANS
- Figure 4.14 Breathing Work Principle
- Figure 4.15 Abdominal Breathing
- Figure 5.1 Method in DEFINE Phase
- Figure 5.2 HRV Sensor
- Figure 5.3 Wrist-attached Electrodes
- Figure 5.4 Experiment Figures
- Figure 5.5 Report of Measurement
- Figure 5.6 Report of Training
- Figure 5.7 Failed User Journey Map
- Figure 5.8 Succeeded User Journey Map
- Figure 6.1 Method in Market Analysis
- Figure 6.2 Product Life Cycle
- Figure 6.3 S.W.O.T
- Figure 6.4 Product Positioning1
- Figure 6.5 Product Positioning2
- Figure 6.6 Product Positioning3
- Figure 7.1 Health Care Platform for Sub-Healthy People

Figure 7.2 Method in Conceptual Product Development
Figure 7.3 Black Box of Tracking System
Figure 7.4 Technology Process of Tracking System
Figure 7.5 Black Box of Training System
Figure 7.6 Technology Process of Training System
Figure 7.7 Functional Structures
Figure 7.8 Solutions for Each Function
Figure 7.9 Engineering Concepts
Figure 7.10 Engineering Concept Evaluations
Figure 11 Users' Pain Points
Figure 7.12 Dandelion Story
Figure 7.13 Communication Links
Figure 7.14 Sensitive Area on Wrist-1
Figure 7.15 Sensitive Area on Wrist-2
Figure 7.16 Wrist Inner Diameter of Female
Figure 7.17 Wrist Inner Diameter of Male
Figure 7.18 Section of Inner Diameter
Figure 7.19 Bracelet Structure
Figure 7.20 Bracelet Structure Evaluation
Figure 7. 21 Models for Bracelet Structure
Figure 7.22 Identity of "White-Collar"
Figure 7.23 Mood Board1
Figure 7.24 Sketch
Figure 7.25 Plasticine Modeling
Figure 7.26 Questionnaire APP
Figure 7.27 Questionnaire Data Collection
Figure 7.28 Graph1
Figure 7.29 Graph2
Figure 7.30 3D Printing Model Test
Figure 7.31 Leather Belt Test
Figure 7.32 Concept Re-evaluation1
Figure 7.33 Concept Re-evaluation2
Figure 7.34 Leather Belt Structure1
Figure 7.35 Leather Belt Structure2
Figure 7.36 Mood Board2
Figure 7.37 Graph3
Figure 8.1 Methods in Deliver
Figure 8.2 Product Appearance
Figure 8.3 Product Usage1
Figure 8.4 Product Usage2
Figure 8.5 Product Usage3
Figure 8.6 Product Usage4
Figure 8.7 Graphic User Interface1
Figure 8.8 Graphic User Interface2

Figure 8.9 Scenario

Figure 8.10 Cover Parts

Figure 8.11 PCB Layout

Figure 8.12 Principle of Fragrance Device

Figure 8.13 Materials

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