An Application of Emotional Factors to Product Design

by

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Abstract

As the ever-increasing competitiveness in product design, functionality and usability is no longer being sufficiently effective differentiators in market place, user's emotional experience plays a key role in purchase decision. From everyday commodities to exclusive luxuries, emotional factors are elementary for design products. This is because consumer emotional response to designed products has a significant effect on how product are interpreted, approached and used. Since emotional factors becomes the new crucial product contributes which grab designers' attention. The knowledge of emotions and emotional factors in product design is important for designers to realize.

In this thesis, emotion triggers and emotional factors in product design will be researched. Theories about emotional design will be introduced. An emotional design tool will be organized and demonstrated through the design projects.

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Chapter1 Introduction

1.1 Problem statement

In recent years, with rapid industrial development, customers need to make decisions regarding a wide variety of products. It seems like the customers are making decisions according to their preference, so designers devote a lot of attention to the products aiming to provide an unforgettable first impression or attractive interaction process. During this short process, a helpful, delighted and user-friendly interaction process, a product resonant with the user. or evoking the memory must become dominant in similar products. Emotion factors help products stand out from the competition with other similarly functioning products. Likewise, the product may have a longer product life cycle after creating emotional attachment with the user. For this reason, pouring the emotion design factors into the design process is a crucial factor for a successful product in the intense competitive market.

A design tool to help research and sort emotions in product design is needed as dealer's market is being transformed into buyer's market while designers focus more on the user's needs and put the user's needs into each design process. To design emotional products, designers need a rigid diagram to demonstrate each process and approach inside. Also, a practical, efficient, and user-centered design tool that helps them find the emotional design potentials and apply the emotional design theories on their design is needed.

1.2 Need for study

It is a natural process to pursue the satisfaction of emotional need when the lower and more basic need is satisfied. Abraham Maslow (1943) proposed a motivational theory in the psychology of human needs. It comprises a five-tier hierarchical model; moving upwards, the needs: physiological, safety, love and belonging, esteem, and self-actualization.

The deficiency needs are the first four levels need from bottom, and the top level contains the growth needs. Individuals must satisfy lower level deficit needs before progressing on to meet higher level growth needs（Maslow, 1943）.

Growth needs stem from a desire to grow as a person. The highest level, self-actualization, will be reached when these growth needs have been reasonably satisfied. People are motivated to achieve certain needs, and some needs take precedence over others for their personal experience, culture or values (Maslow, 1943) .

Figure 1 The five-stages model (Maslow, 1943)

It is important to note that Maslow's (1943) five-stages model has been expanded to include cognitive and aesthetic needs (1970) and later transcendence needs (Maslow, 1970).

Phillips (2017) illustrates the importance of emotion design through putting it on a pyramid. Functional and attractive things are actually perceived by people to "work better." Emotional Products are more successful than others because they satisfy the highest user need.

1.3 Objectives of study

The emotional design revolves around our needs as humans to bond and create a connection between person and product. The objective of this thesis is to figure out how emotion is connected to design, explain why attractive things are perceived to work better, and how emotions change the way the human brain operates.

This thesis will clarify customer's emotional needs systematically and introduce the emotional aspects that need to be considered in design process. The project will provide a flowchart for designers to think about how to add emotional design elements for satisfying user needs.

Besides, this thesis should provide a clue about how designers help build an emotional relationship between user and product. The objectives of the study are as follows:

- Study the relevant knowledge of emotions
- Study the relevant knowledge of emotional-based product design
- Study the cases about emotional factors in products
- Develop an approach for designers to apply emotion factors in product design

1.4 Definition of terms

Emotion: Emotion consists of neural circuits (that are at least partially dedicated), response systems, and a feeling state/process that motivates and organizes cognition and action (Izard, 2010).

Emotional design : Emotional design strives to create products that elicit appropriate emotions ("Emotional Design ," 2002).

Emotional experience: Emotional experience is sustaining, controllable and may reference prior experience. It is less dependent on the self and more representative of the environment's stimulus, (Norman, 2004).

Emotional statement : Emotion statement is impulsive, momentary and autonomous. It could be considered as less representative view of the environment and more dependent on information specified about the self (Norman, 2004).

User centered design: User-centered design (UCD) is an iterative design process in which designers and other stakeholders focus on the users and their needs in each phase of the design process. UCD calls for involving users throughout the design process via a variety of research and design techniques so as to create highly usable and accessible products for them.

1.5 Assumptions

- It is assumed that all the quoted theories and academic viewpoints are correct. The experiments and data cited are the authoritative source.
- It is assumed that all the products can elicit a user's emotional response even though the emotional response is weak.
- It is assumed that emotions can be briefly defined as positive or negative.
- It is assumed users have a complete sensory system to give an emotional response of designed products in this thesis.
- It is assumed that the user's emotional response is measurable and relatively unitary.
- It is assumed products are able to evoke user emotions. The evoked emotion exists long enough for proving the emotion-driven function.
- It is assumed the form, shape, color, and texture are the main four properties for products to determine emotions aroused by products.
- It is assumed that "the product emotions are personal; as our concerns are personal thus our appraisals differ, hence so do our emotions" (Desmet, 2002).

- It is assumed that "emotion are temporal; as in time our attitudes, goals, standards and our focus on products change" (Desmet 2002).

- It is assumed "emotions are mixed; they can be construed as relevant for more than one concern (Desmet 2002).

1.6 Scope & Limits

Scope of study :

- This thesis will focus on emotions that are relatively unitary and simple.
- The products and correspondent emotions discussed in this thesis are positive guidance in the usage scenario and helpful and meaningful for users in a general sense.

 Limits of study :

- Complex emotions will not be discussed in this thesis.
- Emotions that may arouse violence, insult ,attack, self-sabotaging behaviors, or any anti-social behavior will not be discussed and advocated.
- Emotions elicited by accident or are unexpected or undesired during subsequent usage are excluded.

1.7 Procedures & Methodology

The whole thesis follows the steps:

1. Research the etymology and history of emotion.

2. Research the generation of emotion.

3. Research the definition, distinction and classification of emotion.

4. Research emotional design concept.

5. Research on emotional design thinking and procedure.

6. Research on emotional design theories.

7. Research on convert emotional factors into useable design factors?

8. How will designers instill emotional value into their design?

9.Summarize design rules from existing emotional design cases.

10. Provide an emotional design tool.

11. Evaluate and demonstrate the design tool through design projects.

During the research stage, online research, observation, and oral interviews are used. A card- based notation system (Index Card) is used for organizing research information. Case studies are used for summarizing the design diagram. Brainstorming, immersed design thinking, sketches, and CADs model are used in demonstrating the design tool.

1.8 Anticipated outcomes

This introduction part states the importance of emotional factors in a product and industry. Theories behind this phenomenon also are introduced. Through this thesis, designer may consider the existence and importance of emotional factors.

This thesis shows the research process from the origins of emotion to the application of emotional factors in Chapter Two, which may provide an idea for readers to organize research information. The case studies and application section could help designers to apply emotional factors in products to strengthen target emotion when users interact with the product.

The thesis also shows how emotion helps lead user behavior according to designer expectations and how to enhance product identity and competitiveness among similarly functioning products through applying emotional factors.

The cognitive theory and behavioural habits information quoted in Chapter Two could help designers have a deep understanding of customers' motivation and behavior through this thesis. The design tool in Chapter Four could help designers design emotion-driven products. It also shows a systematic thinking mode and design process that can be used for reference.

Chapter 2 literature review

Emotion connects human and world human to understand and learn. In a narrow sense, emotional designs are the product that design aims to provide a positive emotion such as enjoyment, happiness. In a broad sense, emotional design may also contain negative emotions such as sadness and regret. Emotional design refers to all the related emotions produced by the designed product during the interaction process. To create an emotional-based user experience and elicit appropriate emotions, designers need to know emotional design. Though the emotional design is still an emerging concept in the design field, research on emotion has been started in the last century. Before entering the emotional design field, designers should have an overall understanding of emotion such as where does emotion comes from, how emotion is defined from academic view, theories on emotion's classification, and how designers could apply these theories into their design work.

This chapter will be introduced into two parts. The first part will focus on history, definitions, and classification of emotion. The second part will explain what is emotional design, theories on emotional design and how to use these theories. Below is a diagram showing the research process in Chapter 2.
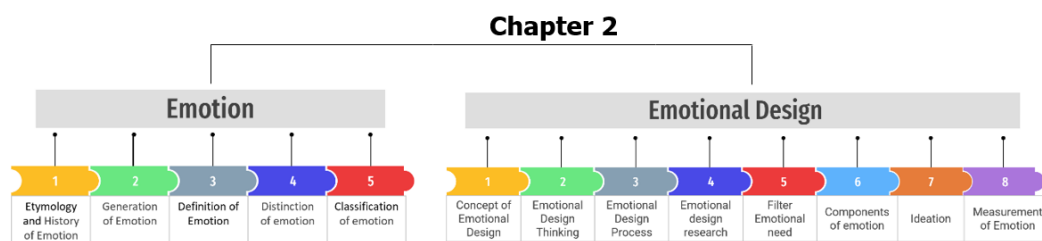
2.1 Emotion

Emotion as the essential element of emotional design needed to be considered throughout the entire design process. The literature review will start with the introduction of emotion. First, history and theories on emotion producing will be introduced for helping designers have an overall understanding of emotion. Then, how to distinguish emotion from similar terms will be introduced later. Finally, the Emotion Wheel as a classification method will be explained.

2.1.1 The Etymology and History of Emotion

The etymology and history of emotion could be traced back to the 17th century, when emotion was a word denoting physical disturbance and bodily movement in both its French and English forms. It could mean a commotion among a group of people, or physical agitation of anything at all, from the weather, or a tree, to the human body. At this stage, emotion is briefly defined as a human-related word. This explains why emotional design is categorized into user-centered design nowadays. After that emotion is defined further. In the 18th century, the emotion came to refer to the bodily stirrings accompanying mental feelings. And for some medical and philosophical writers, the term emotion was reserved for those bodily movements which served as the external signs of inward passions and affections (Dixon, 2012).

Bentham (1996) wrote that "The emotions of the body are received, and with reason, as probable indications of the temperature of the mind" (p.63). This usage was continued into the early 19th century by Cogan (1802), who insisted that the term "emotions" was properly applicable only to those sensible changes and visible effects which particular passions produce upon the frame" (p. 7-8). As Dixon (2012) summarized, that emotions were external and visible effects, also explains why the term sensible was so frequently associated with the term emotion (para. 16).

 According to Dixon (2012), emotion moved from the bodily to the mental domain in the early 19th century, as Scottish philosopher replacing "active power of the mind", "passions" and "affections" with "emotion" in his lectures Scottish philosopher. It was a key moment in the history of our modern concepts of "emotion." Emotion referred to vivid feelings, arising immediately from the consideration of objects, perceived, or remembered, or imagined, or from other prior emotions by Brown (paras. 17-18).

A second key figure was another Edinburgh physician and philosopher, Charles Bell. His brief definition of the term was that "emotions" were certain changes or affections of the mind, as

grief, joy, or astonishment, which could become visible through outward signs on the face or body. He believed that the emotions might proceed from or in any degree pertain to the body. And then, In the late 19th, Darwin and James were both influenced by Brown and Bell (Dixon, 2012, para. 23). As Dixon (2012) summarizes, the term 'emotion' suited the "purposes of a self-consciously secularizing and scientific cadre of psychological theorists, detached as it was from the centuries of moral" and theological connotations that had accrued to the terms 'passion' and 'affection' (Dixon, 2012, para. 16).

Reviewing the history of emotion helps understand why emotion has a close relationship with psychology, neurology, and religion. It also explains why the boundary between the term "emotion" "feeling" and "affection" are blurred when we use them today. Before distinguishing emotion from similar words, the definition of emotion should be known.

After emotion's appearance in the last century, people try to figure out where emotion comes from and how emotion comes into being. And in all the theories on emotion from somatic to cognitive there exists a rich store of ideas about how the human body responds to stimuli and produces emotion. These theories also explain customer psychology and behavior. It also helps designers know what are stimuli and how stimuli work.

2.1.2 The Generation of Emotion

Throughout emotion's developed history, several different schools of academics have unlike thought on explaining human emotion's production. Some of these ancient theories could be seen as fundamental theories of contemporary's knowledge structure of emotional design. This section will introduce various theories on emotion production from medical, psychological and sociological views.

The theory on form of emotion could be dated to the 19th century. In Pre-modern times, emotion was still an abstract concept. Aristotle believed that emotions were an essential component of virtue (Bartlett & Collins, 2011). In the Aristotelian view, all emotions corresponded to appetites or capacities. During the Middle Ages, the Aristotelian view was adopted and further developed by scholasticism and Thomas Aquinas (Loughlin, 2010) Early modern views on emotion were developed in the works of philosophers.

In the mid-late 19th century, Charles Darwin argued that emotions served no evolved purpose for humans, neither in communication, nor in aiding survival in his book *The Expression of the Emotions in Man and Animals* (Darwin, 1872). He thought emotions evolved via the inheritance of acquired character. He concluded that some expressions had cross-cultural universality from his non-verbal expression research. He also detailed animal's homologous expressions of emotions. Today, exploring the relationship between expression and emotion is still widely accepted by researchers to classify emotions and discover new emotion.

Contemporary views along the evolutionary psychology spectrum posit that both basic emotions and social emotions evolved to motivate behaviors that were adaptive in the ancestral environment (Gaulin & McBurney, 2004). As technology developed, research on emotion's form stepped into neurology. Paul D. MacLean claims that emotion competes with even more instinctive responses and more abstract reasoning. He thinks the increased potential in neuroimaging has also allowed investigation into evolutionarily ancient parts of the brain (cited in Gaulin & McBurney, 2004). Important neurological advances were derived from these perspectives in the 1990s by Joseph E. LeDoux and António Damásio. Research on social emotion also focuses on the physical displays of emotion including body language of animals and humans. For example, spite seems to work against the individual but it can establish an individual's reputation as someone to

be feared. Shame and pride can motivate behaviors that help one maintain one's standing in a community, and self-esteem is one's estimate of one's status (Gaulin & McBurney, 2004).

James-Langue theory of emotion suggest that people see an external stimulus that leads to a physiological reaction. The emotional reaction is dependent upon how people interpret those physical reactions. For example, suppose a person is walking in the woods and see a grizzly bear. The person begins to tremble, and his heart begins to race. The James-Lange theory proposes that the person will interpret his or her physical reactions and conclude that he or she is frightened. According to this theory of emotion, the person is not trembling because he or she is frightened. Instead, he or she feels frightened because he or she is trembling (Cherry , 2020).

Walter Cannon disagreed with the James-Lange theory of emotion on several different grounds. First, he suggested, people can experience physiological reactions linked to emotions without actually feeling those emotions. For example, the person's heart might race because he or she has been exercising and not because he or she is afraid. Cannon also suggested that emotional responses occur much too quickly for them to be simply products of physical states. When a person encounters a danger in the environment, he or she will often feel afraid before starting to experience the physical symptoms associated with fear such as shaking hands, rapid breathing, and a racing heart. In summary, Cannon and Bard believed physical and psychological experiences of emotion happen at the same time and that one does not cause the other (Friedman, 2010).

Schachter and Singer's theory draws on both the James-Lange theory and the Cannon-Bard theory of emotion. They provided a two-factor theory of emotion. Like the James-Lange theory, the Schachter-Singer theory proposes that people do infer emotions based on physiological responses. The critical factor is the situation and the cognitive interpretation that people use to label that emotion (Schachter & Singer, 1962). In the meanwhile, like the Cannon-Bard theory, the Schachter-Singer theory also suggests that similar physiological responses can produce varying emotions. "If you experience a racing heart and sweating palms during an important math exam, you will probably identify the emotion as anxiety. If you experience the same physical responses on a date with your significant other, you might interpret those responses as love, affection, or arousal" (Schachter & Singer, 1962, p. 393).

All these theories mentioned above could be seen as somatic theory. There are cognitive appraisal and perceptual theories which have a high similarity to contemporary's emotional theory. According to appraisal theories of emotion, thinking must occur first before experiencing emotion. Cognitive appraisal theory believes the sequence of events first involves a stimulus, followed by thought which then leads to the simultaneous experience of a physiological response and the emotion. For example, if a person encounters a bear in the woods, he or she might immediately begin to think that he or she is in great danger. This then leads to the emotional experience of fear and the physical reactions associated with the fight-or-flight response (Cherry, 2019).

Combining somatic theory and cognitive theories of emotion, Perceptual theory believes that bodily responses are central to emotions. It insists that human body are causally triggered by certain situation and perceive related content of emotion (Prinz, 2004).

Affective events theory is a communication-based theory that believes the causes, structures, and consequences of emotional experience influence attitudes and behavior. It suggests that emotions are influenced and caused by events which in turn influence attitudes and behaviors (Weiss, 1996). This theory is accepted by Desmet (2002). Beside affective events, Desmet also brought up affective agents and objects which will be introduced later.

Instead of seeing emotion as a purely internal process, a situated perspective on emotion, developed by Paul E. Griffiths and Andrea Scarantino (2005), emphasizes the importance of external factors in the development and communication of emotion. They believed emotion as the product of an organism investigating its environment, and observing the responses of other organisms. Griffiths and Scarantino (2005) suggested that this perspective on emotion could be helpful in understanding phobias, as well as the emotions of infants and animals.

Based on motivation of researching emotion's production, technology on emotion research could continue developing. Pioneer's achievement laid a foundation of today's eye tracking technology and Kansei engineering. These theories also stimulate psychology's developing. Desmet and Frijda et al (1994) have a chance to develop their model of emotion based on these knowledge structures. Designers could also reference and apply these theories to their design method.

2.1.3 The Definition of Emotion

Since emotion is interdisciplinary, it could be defined from different academic perspectives. These definitions are widely accepted by the design field and help designers have a clear goal in the research stage. It also helps the designer to extract user's emotional needs and filter unrelated information. This section will introduce the emotion's definition from different views.

Emotions are biological states associated with the nervous system (Damasio, 1998), brought on by neurophysiological changes variously associated with thoughts, feelings, behavioral responses, and a degree of pleasure or displeasure (Ekman & Davidson, 1994). Emotion was summarized by Izard (2010) in one sentence: "Emotion consists of neural circuits, response systems, and a feeling state/process that motivates and organizes cognition and action" (p. 367). These definitions all support that emotion is a series of chemical reactions in the human body.

In psychology, emotion was defined as a mental state associated with the nervous system (Damasio, 1998) brought on by chemical changes variously associated with thoughts, feelings, behavioral responses, and a degree of pleasure or displeasure (Schacter, Gilbert, & Wegner, 2010). Emotions can be defined as a positive or negative experience that is associated with a particular pattern of physiological activity. Emotions produce different physiological, behavioral, and cognitive changes. The original role of emotions was to motivate adaptive behaviors that in the past would have contributed to the passing on of genes through survival, reproduction, and kin selection (Pinker, 2009). Oxford dictionary defined that emotion is a strong feeling deriving from one's circumstances, mood, or relationships with others (Schacter, Gilbert, & Wegner, 2011). In practical terms, Joseph LeDoux (2019) has defined emotions as the result of a cognitive and conscious process that occurs in response to a body system response to a trigger. This psychological theory supports that emotion influences a user's behavior and purchase decision. Form these definitions, feeling, mood, and affect are frequently used in explaining emotion. In the stage of problem research, users may have unclear expressions using these similar terms. The designer should lead the research direction back to emotion.

2.1.4. The distinction of Emotion

To find emotional design opportunities accurately, the designer should filter user needs and find useful emotional information since emotion is similar to terms such as feelings, moods and affect. To avoid misunderstanding, designers should distinguish emotion from feelings, moods, and affect and also extract emotional needs.

Emotion is usually caused by some special reason and it is a short-lived behavior. For example, purchasing a new cellphone creates happiness, but it won't last long and will be replaced by another emotion, for example, overpaying for this new cellphone bringing sadness. On the contrary, the mood is more long-lasting and produced for no reason. There are two basic moods that are positive and negative. Emotion could be reflected by facial expressions but mood cannot be exhibited. Moods are low intensity, diffuse, and relatively enduring affective states without a salient antecedent cause and therefore little cognitive content, whereas emotions "are more intense, short-lived and usually have a definite cause and cognitive content" (Forgas, 1992, p. 230).

Feeling and emotion are not interchangeable. Both emotional experiences and physical sensations, such as hunger or pain, bring about feelings. Feelings are experienced consciously. Comparing with feelings, emotions are not conscious but instead manifest in the unconscious mind. Affect refers to the positive or negative personal reactions or feelings that we experience. Affect is often used as an umbrella term to refer to moods and emotions. Emotion can be regarded as one manifestation of affect.

In summary, a designer could only evoke the user's emotion purposely through stimuli since it is a controllable variable compared with mood, feeling. Feeling and mood could reflect the user's attitude. A designer could observe the user's emotion through feeling and mood, but cannot control it.

2.1.5 The Classification of Emotion

Distinguishing emotion helps designers extract emotional needs from user research. Next, the designer may need to classify user's emotional needs or find the components of the target emotion. There are various emotion classification methods; Plutchik (1980) and his emotion wheel are widely accepted and used by designers.

Before introducing Plutchik's emotion wheel, Paul Ekman (2014) and his six basic emotions should be mentioned. He believes that emotions are discrete, measurable, and physiologically distinct. He found that certain emotions appeared to be universally recognized, even in cultures that were preliterate and could not have learned associations for facial expressions through media. He also found that when participants contorted their facial muscles into distinct facial expressions (for example, disgust), they reported subjective and physiological experiences that matched the distinct facial expressions. His research findings led him to classify six emotions as basic: anger, disgust, fear, happiness, sadness, and surprise. These six basic emotions are still used in Psychology.

After that, Ekman and Cordaro (2011) theorized that other universal emotions may exist beyond these six. According to this, Cordaro, Keltner, Tshering, Wangchuck, and Flynn (2016) extended the list of universal emotions. The new universal emotion list contains new emotions : amusement, awe, contentment, desire, embarrassment, pain, relief, and sympathy. After that, they also found evidence for boredom, confusion, interest, pride, and shame facial expressions, as well as contempt, interest, relief, and triumph vocal expressions.

Robert Plutchik (1980) is another influential theorist who agreed with Ekman's biologically driven perspective but developed the "wheel of emotions", suggesting eight primary emotions grouped on a positive or negative basis: joy versus sadness; anger versus fear; trust versus disgust; and surprise versus anticipation. Some basic emotions can be modified to form complex emotions. The complex emotions could arise from cultural conditioning or association combined with the basic emotions. Alternatively, similar to the way primary colors combine, primary emotions could blend to form the full spectrum of human emotional experience. For example, interpersonal anger and disgust could blend to form contempt. Relationships exist between basic emotions, resulting in positive or negative influences.

Plutchik (2020) developed both 2 and 3-dimensional models for this. The wheel can be used by designers to examine the complexities of emotion and to act as a "color palette" for emotion design – with the idea being that blending different emotions will create different levels of emotional response and intensities of that response. The wheel is a simple model and there are almost certainly additional emotional inferences that could be drawn from a more complex model-however, it focuses on the basic emotions that most designers are likely to want to elicit in their users and as such provides a useful starting point.

Plutchick also provides a method for combining and splitting emotion. It helps to explore user emotion needs in-depth. Designer could find sub emotion anticipation and joy as inspiration direction though user only state "optimism". This also helps designer to map user emotional needs to design elements. For example, if there is no evidence showing the relationship between Optimism and product material, the designer could research materials which are able to evoke anticipation and joy.

As the emotion wheel shows, there are eight basic emotions: joy, love, fear, surprise, sadness, disgust, anger, and anticipation. According to intensity, each emotion could derive other emotions around the basic emotion. For instance, Anger is the basic emotion, but reducing the intensity can obtain annoyance, while increasing the intensity can obtain rage. Combining basic emotion could get a new complex emotion as the wheel shows:

Anticipation + Joy = Optimism (With its opposite being disapproval)

Joy + Trust = Love (With its opposite being remorse)

Trust + Fear =Submission (with its opposite being contempt)

Fear + Surprise =Awe (with its opposite being aggression)

Surprise + Sadness = Disapproval (with its opposite being optimism)

Sadness + Disgust = Remorse (with its opposite being love)

Disgust + Anger = Contempt (with its opposite being submission)

Anger + Anticipation = Aggressiveness (with its opposite being awe)

Figure 2 Wheel of Emotion (Plutchik, 2020)

Factor analysis is another method to map emotion-related responses onto a more limited number of dimensions. It attempts to boil emotions down to underlying dimensions that capture the similarities and differences between experiences (Osgood, Suci, & Tannenbaum, 1957). Often, the first two dimensions uncovered by factor analysis are valence and arousal. These two dimensions can be depicted on a two-dimensional coordinate map (Schacter, Gilbert, & Wegner, 2010). This map has been theorized to capture one important component of emotion called core affect (Russell, 2003).

According to the above, it could be summarized that the intensity of emotion is the main dividing criterion. Homology and similarity regularly appear in the emotion list. Emotion could derive endless similar emotion words according to granularity. As previously mentioned, though it is hard to find supportive evidence showing the relationship between design elements and various emotions, designers could extract core emotion as a research direction according the emotion's homology and combination method.

2.2 Emotional design

The second part of Chapter 2 will introduce how emotion is related to product design, the definition of emotional design, how Desmet (2004) and Norman (2004) applied emotion theories in the design process and the influence of these achievements in the emotional design field. This section will also introduce the emotional design thinking and emotional design approach. Designers could reference the user-centered design process and how to complete the user's emotional research.

The sequence of this section will follow the diagram below:
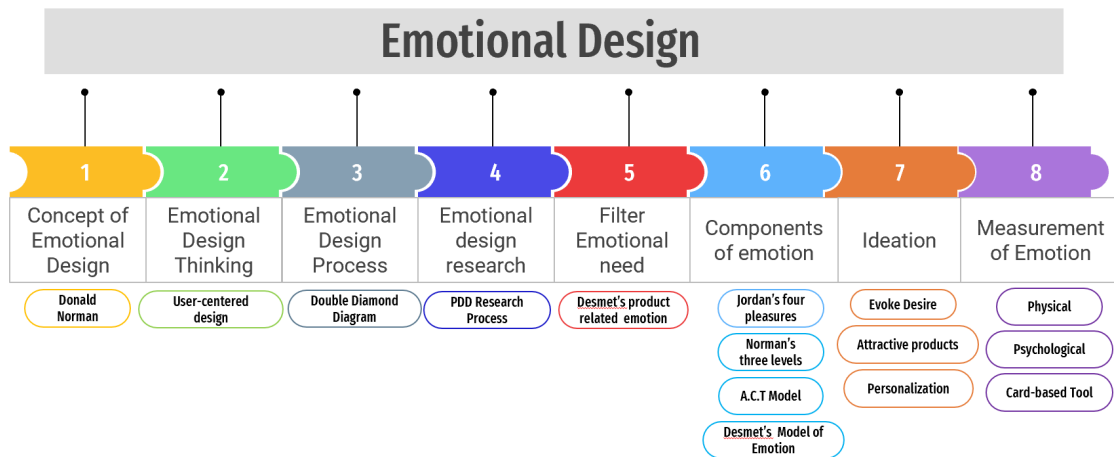
2.2.1 Emotional design products

Before introducing theories on emotional design, designers should know what is emotional design and how emotion is related to design. Emotion could be evoked by designed product as long as there is an interaction between the user and the product. As the research on emotion developed, designers notice the emotional factor in design no matter if the creator did so with a purpose or not because "Everything around has been designed in some way and all design ultimately produces an emotion. People experience an emotional reaction to their environment moment-by-moment: a like or a dislike, elation, joy, frustration. People feel it. It is personal" (Philips, 2017, para. 3). Designers have started to notice the importance of emotional design and started to search rules for emotional design.

Philips mentioned an old adage to explain the existence of an interaction between user and product: "interaction with any product produces an experience (emotion) whether it had user experience or not" (Philips, 2017, para. 4). In industrial design, products elicit emotion from their user, whether good or not. This reflects on the definition of user experience design: "User experience design considers how a user interacts with and responds to an interface, service or product." (Philips, 2017, para. 5). He believes the response is an emotion. Thus, designers not only strive to design usable and functional products but also generate a certain emotional effect on the user while they are interacting with the product—usually a positive emotional effect —and try to maintain it throughout the user journey (Philips, 2017).

The concept of emotional design has appeared gradually, and is based on user-centered design. Research and theories on emotional design rise in response. Emotional design is not just about a product's design interaction. It's a moment-by-moment effect "in the flow" and reacts on three levels in the brain: visceral, behavioral, and reflective (Philips, 2017). For Donald A. Norman (2004), emotional design is a product of "recognition" about the importance of emotions and aesthetics in design. Positive experiences inspire people to explore more, while negative ones protect us from repeating mistakes. Humans form emotional connections with objects on visceral, behavioral, and reflective levels.

Donald A. Norman (2004) explained how emotion affect the customer's decision in his book emotional design: why we like everyday things? He proposed three levels of emotional design, which provides a method helps designer to evoke positive emotion in customer and stimulate purchase. He believes emotions change the way the human mind solves problems—the emotional system changes how the cognitive system operates. Human attributes result from three different levels of the brain: the automatic, prewired layer, called the visceral level; the part that contains the brain processes that control everyday behavior, known as the behavioral level; and the contemplative part of the brain, or the reflective level.

After realizing the concept of emotional design, designers should know how to complete an emotional design project. The design process will still follow user centered design thinking and process.

2.2.2 User-centered design

Before start entering emotional design process, designers should know the basic design thinking that emotional design follows. Emotion design has an inseparable relationship with user-centered design since building in emotional value to product is the end intent of most user-centered design processes. As Norman (2004) states "I learned that products can be more than the sum of the functions they perform. Their real value can be in the fulfillment of people's emotional needs, and one of the most important needs of all is to establish one's self-image and one's place in the world" (p. 87). To apply accurate emotion into products and accepted by users, the designer should always follow the user-centered design. The process and approach used in user-centered design also provides an idea for emotional design.

User-centered design (UCD) is more than a design thinking, it is also a methodology that places users at the center, and end-users will influence how a design task takes shape. User-centered design is an iterative design process in which designers and other stakeholders focus on the users and their needs in each phase of the design process. UCD encourages involving users throughout the design process. The research and design approaches in the process are to create highly usable and accessible products for the user (Gladkiy, 2019).

According to Gladkiy (2019), UCD is empathetic, iterative, and interdisciplinary. User-centered design should have a clear understanding of the users, tasks, and environments; It is also

an evaluation-driven design; User-center design considers the overall consumer experience; Users or consumers should always be considered in the design and production process.

For designers there are several basic steps to follow in user-centered design:

Specify the use context — collect information about their users' needs;

Specify clear business requirements — the designers and the stakeholders provide detailed specifications for the new product;

Create unique design solutions — building a solution, from rough concept to finished design;

Evaluate designs — through usability testing with actual users;

Implementation — the process of developing and delivering the product;

Deployment — the final product is frequently evaluated, as consumer needs evolve and change. (Gladkiy, 2019, para. 5)
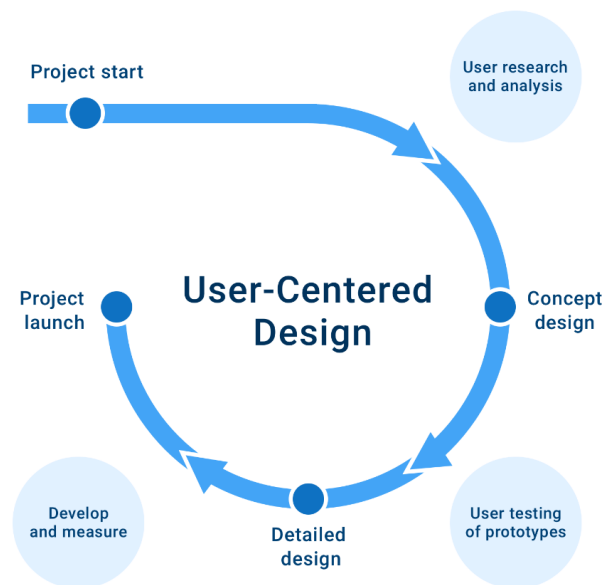
Figure 3 User Centered Design Process (Gladkiy, 2019)

2.2.3 Double diamond

      After knowing the design thinking, designers also need to know the emotional design process. As mentioned above, the emotional design could follows basic user-centered design process: discover the problem, define the design area, develop a solution and deliver design solution. Double Diamond is authoritative for proving a clear and comprehensive design process. This model is developed by the British Design Council in 2004. It is divided into four phases — Discover, Define, Develop, and Deliver. The two diamonds represent the iterative divergent and convergent thinking process. It starts from exploring an issue widely or deeply and then taking focused action (British Design Council, 2019).
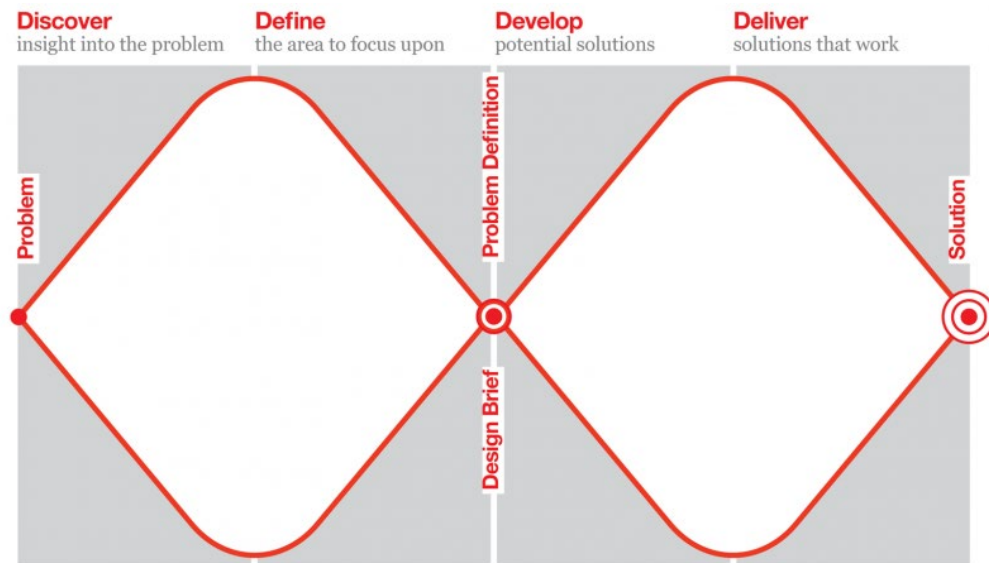
Figure 4 Double Diamond Design Process (British Design Council, 2019)

      According to the Design Council (2019), The four phases could be explained in detail as follows:

      Discover : The first diamond helps people understand, rather than simply assume, what the problem is. It involves speaking to and spending time with people who are affected by the issue.

Define : The insight gather from the discovery phase can help you to define the challenge in a different way.

Develop : The second diamond encourage people to give different answers to the clearly defined problem, seeking inspiration from elsewhere and co-designing with a range of different people.

Deliver: Delivery involves testing out different solutions as small-scale, rejecting those that will not work and improving the ones that will (British Design Council, 2019 , para. 5-8).

Double diamond provides a basic frame for user-centered design process that designers could adjust it accordingly while using it. For emotional design, user emotional needs in the early design stage is essential and the designer should have a deep understanding of it.

2.2.4 PDD research approach

Researching is the first step in the emotional design process. Researching stage in emotional design requires the designer has a deeper empathy and systematic research process. Crossley (2003) describes an approach for designs to have a comprehensive user-centered research. There are five overlapping stages in this approach: immersing, storytelling, observing, creating, and communicating. It is widely accepted as a design tool for helping designers to have insight into the user's background and extract user emotional needs in detail.

Immersing   Storytelling   Observing   Creating   Communicating
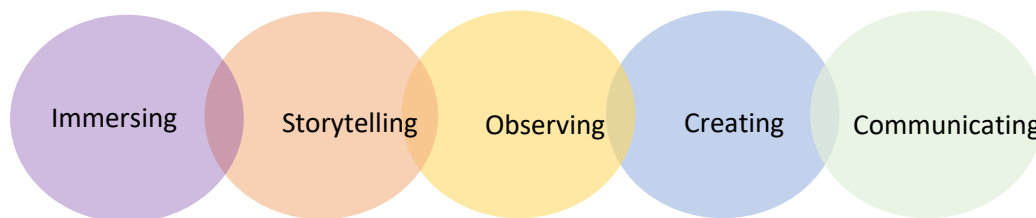
Immersing stage requires designers to immerse themselves in the user's lives and environments. As Crossly (2003) states "The environments that people craft around themselves are rich within formation about personalities, values, and lifestyles" (p. 38) The purpose of this is

to help designers gain "clues regarding anticipated behaviors" and "initial impressions gained are often extremely accurate" (p. 38).

Storytelling stage requires users to tell designers of their experiences through stories so that designers can "…enter into a dialogue with their meaning system."(Crossly, 2003, p. 39) This is because designing a relationship with a product "…we need to understand fully people's relationships with objects, other people, environments, and so on." (p. 39). This stage helps designers gain ideas to reach a reflective level design.

Observing stage is to watch users in action using products. This is to find "…what they do, what frustrates them and what gives them satisfaction." (p. 40). This stage help designers understand how user interacts with the product and enhance behavioral level design.

Creating stage is for helping designers to "…focus on defining the essence of the problem and creating relevant ideas' (Lundahl, 2006, p. 32). Such ideas would be in visual methods that both the designer and people can understand. A suitable way would be through iterative "Protocepts", a conceptual rough prototype, which allows to "…gauge emotive response behaviors" (Lundahl, 2006, p. 32). This is the core process of effective, user-centered design. It helps the designer to apply previous research information into the design to match user desires.

Communicating stage is presenting the findings in a visual manner. In turn, as the designer has immersed into the users' space, the findings gathered should also be presented as an "immersive space" for others to take in. It could be a method through which the designers capture the desired experience, and bring visions to life, enabling users to communicate complex ideas and feelings effectively.

This approach provides a basic flow path for user-centered research, which is suggested to be applied accordingly in the early stage of emotional design.

2.2.5 Filter Product relevant emotions

Organizing researching information is also important for designers. There are numerous words to describe emotion from the user side. Designers need to filter these words and extract useful ones for the project. As Frijda found, some emotion words are ambiguous (cited in Desmet, 2002). Desmet provides an example of how to filter and classify emotion words. When he assembled a set of emotion words from user research, he found that not every participant user is familiar with the emotional words. Some words that appeared are even not relevant to emotion. Thus, for reasons of comprehensibility, a set of product relevant emotions that include clear and familiar emotions is suggested for the designer. Desmet (2002) set two axes, one to measure the degree of pleasant, the other one to measure the degree of activation. Screening some ambiguous words, he summarized 41 product relevant emotions that are sufficiently extensive to represent a general overview of the full repertoire of human emotions from a set of 347 emotion words. Thus, these 41 emotions will form the base for this project's list of emotion words.
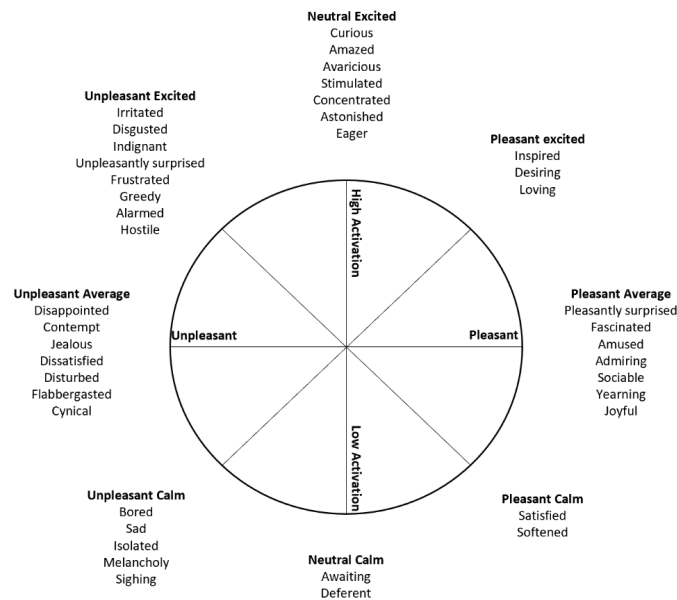
Figure 5 41 product relevant emotion (Desmet, 2002)

It is important to stress that the set of product emotions does not provide a complete overview of all the emotions that a product can possibly elicit. A designer could have his or her own method to filter useful emotion words according to the project.

2.2.6 The components of emotion

Analyzing user's emotional information and emotional needs is also essential for designers. The emotion that users describe is often a hybrid of several emotions at different levels. Splitting emotion also provides an idea for designers to brainstorm design elements. Though a designer obtains a specific target emotion to be designed from the previous research steps, he or she may need to analyze this target emotion at different levels to get more design ideas.

2.2.6.1 Jordan's pleasure model

Patrick Jordan (1990) divided pleasure into four levels. Compared with Norman's three levels, he divided the reflective level into ideological and sociological aspects in his model. He proposed a pleasure-based approach to the human factor, where pleasure with a product is defined as the emotional, hedonic, and practical benefits associated with products. Designers could get inspiration to split one emotion into four levels subbing emotion from Jordan's pleasure model.
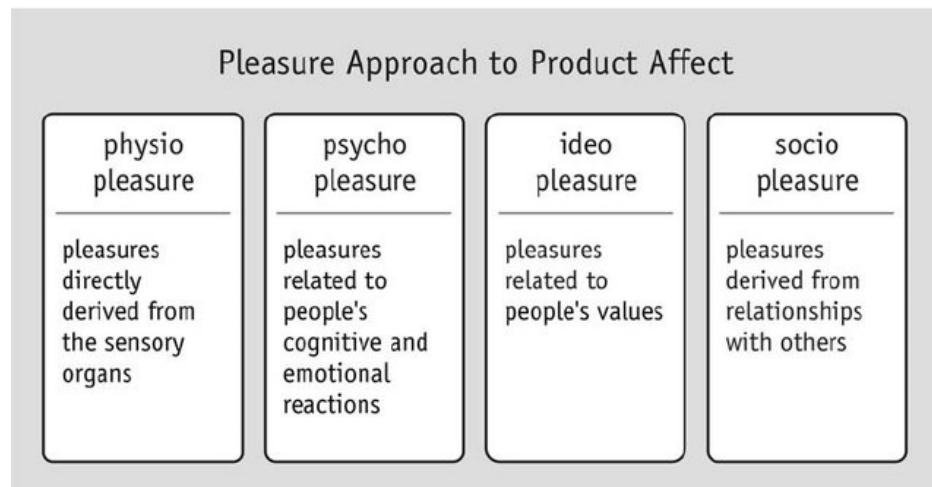
Figure 6 Four Pleasures Approach to Product Affect (Jordan, 1990)

As the figure shows, there are four types of pleasure classified by four levels. Physio-pleasure has to do with the body and with pleasures directly derived from the sensory organs (such as touch, taste, and smell). Products are perceived with the sensory organs and therefore a direct source of physio-pleasure or displeasure. For example, a mobile phone can generate physio-pleasure because of its soft touch and elegant appearance. Psycho-pleasure is related to people's cognitive and emotional reactions and has to do with the cognitive demands of using products. A

text processor that is easy to operate provides a higher level of psycho-pleasure than one that is cumbersome and illogical because it enables the user to complete the task more easily. Ideo-pleasure is related to people's values (i.e. pleasures from 'theoretical' entities such as books). Ideo-pleasure experienced in response to products is related to the values that the products embody. Socio-pleasure is the enjoyment derived from relationships with others. This type of pleasure is relevant for those products that facilitate social interactions.

2.2.6.2 Norman and his three levels theory

Norman (2004) and his three levels theory provides designers ideas of design elements at different level. According to Norman, people's emotional responses caused by the designed product are on three levels: visceral, behavioral, and reflective. The three levels are time relative and intertwined.

Figure 7 Three levels of Emotional Design (Norman, 2004)
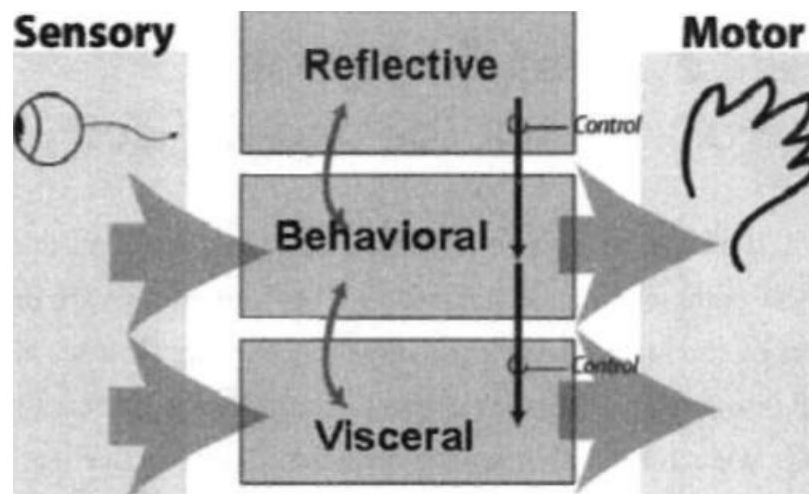
The conflict among three levels are common in design and requirement in these three design levels are different. According to Norman (2004), these three levels can be mapped to product characteristics like :

Visceral design: Appearance

Behavioral design: The pleasure and effectiveness of use

Reflective design: Self- image, personal satisfaction, memories

Norman (2004) pointed out the real user experience and design requirements involve all three levels through the three levels are described separately. In order to show designers how to apply this theory to design works, these three levels will be explained in detail.

Visceral level is about "evoking user inner instincts, human drives; The human preference for faces and bodies that are symmetrical presumably reflects selection of the fittest; non-symmetrical bodies probably are the result of some deficiency in the genes or the maturation process" (Norman, 2004, p. 66). Users selections for size, color, and appearance, and what people are biologically disposed to think of as attractive derives from these considerations. At the visceral level, physical features such as look, feel and sounds dominate. "The principles underlying visceral design are wired in, consistent across people and cultures" (p. 67). Norman (2004) describes the best circumstances are that the visceral reaction to product appearance works faultlessly so that user takes one look and decide to buy it. After that, they might ask what does it do and how much is it. In summary, the visceral level is about human's five senses which is similar to Jordan's Physio-pleasure. This "is the pleasure of the body: sights, sound, smells, tastes and touch" (Norman, 2004, P. 105).

The behavioural level is about usability. Product appearance is less relevant but it is still a contributing factor for usage as the product appearance implies an expectation of how the product should be operated, and what this feels like. Norman (2004) defined four key factors in good behavioral level design: function, understandability, usability, and physical feel. For behavioral design, function comes first and foremost. After function comes understanding. An important component of understanding comes from feedback: a device has to give continual feedback so that a user knows that it is working, that any commands, button presses, or other requests have actually been received. Usage is the critical test of a product: Here is where it stands alone, unsupported by

advertising, or merchandising material. All that matters is how well the product performs, and how comfortable the person using it feels with the operation. In conclusion, the good behavioral design should be human-centered, focusing upon understanding and satisfying the needs of the people who actually use the product.

At the reflective level, it points to our culture and about the meaning of a product or its use (Norman 2004). It's how we see the product reflecting our self-image and aspirations to others. This is due to products playing an important role in the statements they make to others. Additionally, it can be in relation to the personal meanings of products, our memories or, associations. "While attractiveness is a visceral level, beauty comes from reflective level" (Norman, 2004, p. 87) The message, culture, conventions, and meaning, learned in whatever society you inhabit, are the essence of reflective design. Prestige, perceived rarity, and exclusiveness work at the reflective level (Norman, 2004) Reflective-level operations often determine a person's overall impression of a product. Here, a user thinks back about the product, reflecting upon its total appeal and the experience of using it. Here is where many factors come into play and where the deficiencies of one aspect can be outweighed by the strengths of another. Minor difficulties might very well be overlooked in the overall assessment—or enhanced, blown all out of proportion. The overall impact of a product comes through reflection—in retrospective memory and reassessment. Customer relationships play a major role at the reflective level, so much so that a good relationship can completely reverse an otherwise negative experience with the product (Norman, 2004). Norman's three levels are widely accepted by designers from the different design industries.

2.2.6.3 A.C.T Model

Van Gorp (2013) also believed the A.C.T. model is a rule for designing successful emotional design products and classified the relationship between emotional product and user into three stages: attract, converse, and transact. The terms in the acronym A.C.T. were chosen to help designers understand the requirements they need to fulfill at each stage: Attract, Converse, Transact. A.C.T. explores the relationship between Sternberg's levels of love (passion, intimacy, and commitment) and product requirements to produce a model that is both more prescriptive for designers and more communicative for business stakeholders (Van Gorp, 2013).
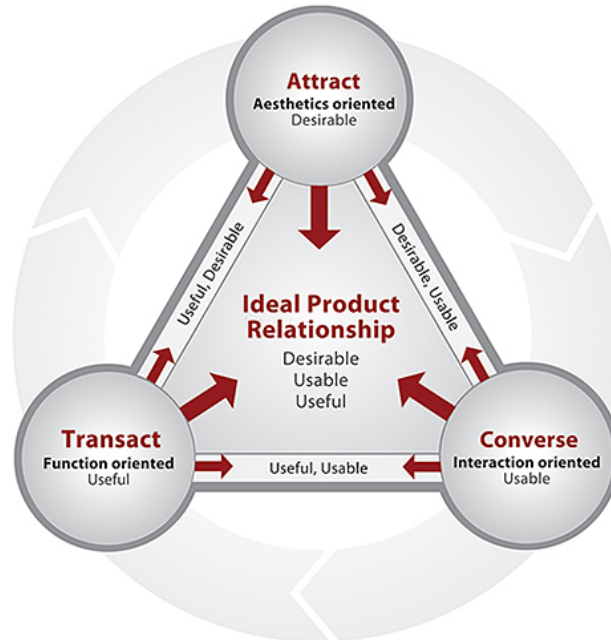
Figure 8 A.C.T Model (Van Gorp, 2009)

According to Van Gorp (2009), the relationship between user and product could be summarized into three phases: Attract, converse and transact. For the attract phase, designer should focus on design requirements such as desirability, or aesthetic properties of the product. For the converse stage, requirements such as usability and interaction style are more important. In the transact stage, usefulness, functionality, product commitment are decisive factors. It could be concluded that the A.C.T model supports Norman's three levels of emotional design. They both classify design requirements in three stages of the user experience process and the design requirements are similar. They both provide designers a guideline about designing emotional design at different stages.

2.2.6.4 Desmet's emotional response model

After analyzing user's emotional need, realizing how user produce an emotion through a product is also necessary for designers. Desmet's (2002) great achievements in emotional design needs to mentioned. He developed an emotional response model that explains how and why emotion are produced through a design perspective. He also categorized stimuli types and user concern types as two essential factors in producing emotion.
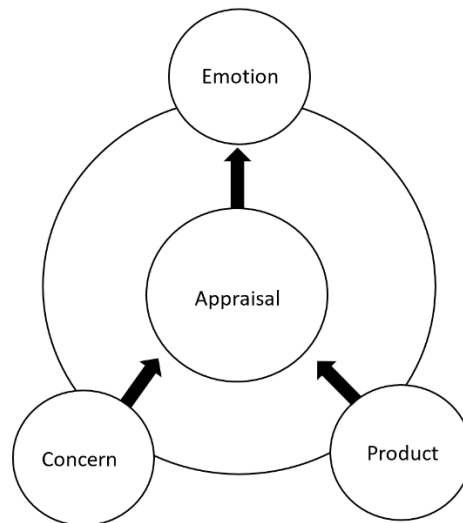
Figure 9 Model of emotions for product appearance (Desmet, 2002)

As the figure shows, Desmet (2002) came up with a model explaining how products elicit emotions. This model is general and applies to all human emotions. Based upon Russell's circumplex of emotions, Desmet summarized seven pleasant and seven unpleasant emotions most commonly experienced emotions for the user in this model, including inspiration, desire, pleasant surprise, amusement, satisfaction, admiration, fascination, boredom, disgust, unpleasant surprise, dissatisfaction, disappointment, indignation, and contempt. There are three key variables to Desmet's (2002) model: product appraisal, product concern, and product focus. These three variables, and their interplay, determine if a stimulus elicits emotion, and if so, which emotion is experienced. Realizing these three variables could help designers have a better understanding of user psychology and purchase motivation.

The first variable is concern. Human concerns are 'desired end-states' and every emotion hides a concern. Concerns can be seen as points of reference during the appraisal process (Frijda, 1994). Thus, the meaning of a stimulus to a human being is determined by an appraised concern match or not. Respect, safety, and love are general concerns; getting to the office on time is a personal concern. Concerns relevant to products are attitudes, goals, and standards. Knowledge and expectations are not a concern type but are relative to the appraisal of novelty (Desmet, 2002). The concern could be explained by combining with the figures of attitude, goals, and standards.
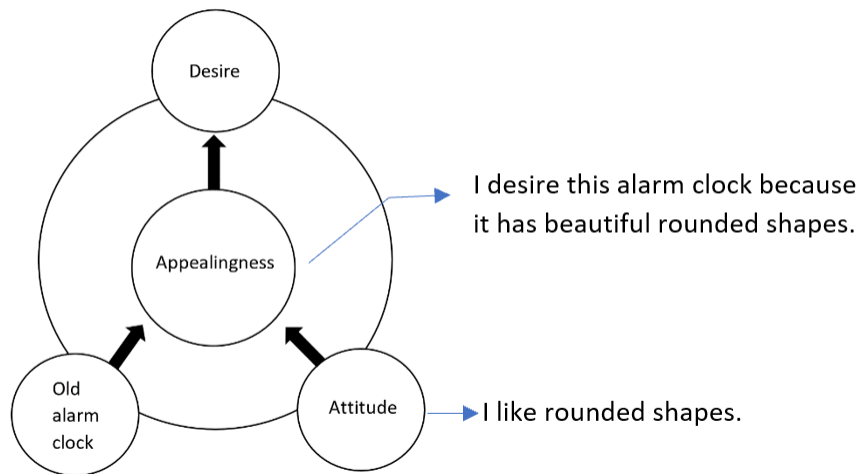
Attitudes are our dispositional likes (or dislikes) for certain objects or attributes of objects; they are our tastes for things. Attitudes can be manipulated by personal meaning due to the significant personal experience they have with the product. Appealingness is the appraisal of attitudes (Desmet,2002). These four decisive factors will be introduced separately with examples.
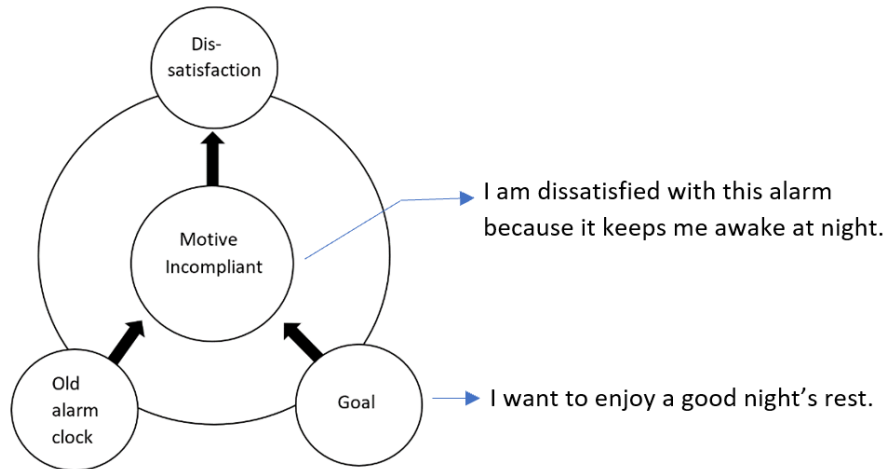
Goals are something users want to obtain; it is how the user would like things to be. Humans have various goals that relate to consumer products; Customers buy or own products because they believe the products can help them achieve something, or because they fulfill a need. Goals are relevant to people's personal well-being (Desmet, 2002).
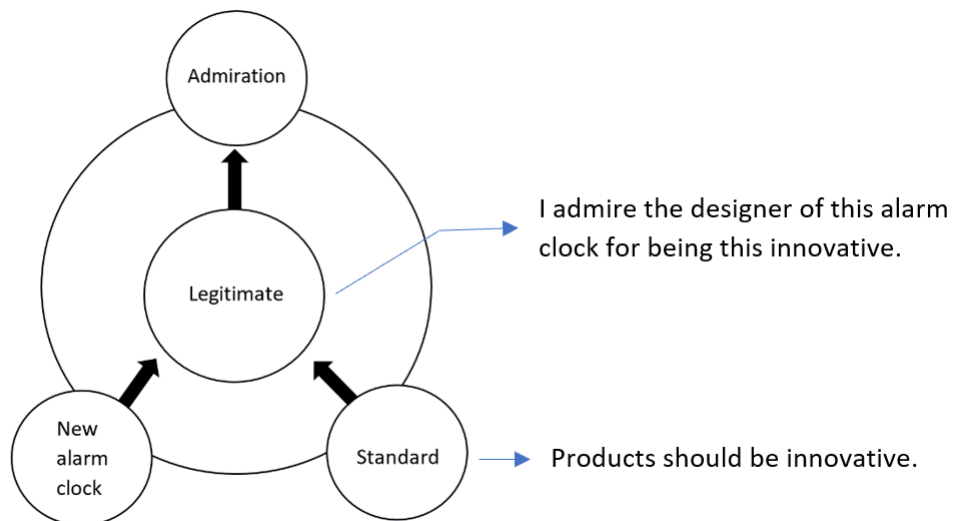
Standards are beliefs, norms or conventions of how user think things should be. Whereas goals refer to the state of affairs user want to obtain, standards are the state of affairs user believe ought to be. Standards are relevant for the preservation of user's social structures. Legitimacy is the appraisal of standards (Desmet, 2002).

The second variable is appraisal; appraisal is core to the product emotion model because appraisal elicits emotion (Roseman & Smith, 2001). An appraisal is a judgement of the significance of a product for our concerns. It is a non-intellectual in the sense that is automatic and unconscious (Desmet, 2002). The specific emotion that is experienced depends on the appraisal type, of which there are four: Appealingness, motive compliance, legitimacy and novelty. Appealingness is the appraisal of our attitudes. Motive compliance is the appraisal of our goals. Legitimacy is the appraisal of our standards. Novelty is the appraisal of our knowledge and expectations (Desmet, 2002).

The third variable is focus; products can evoke emotions in various ways, and it is not only the product itself but the meaning that is interpreted from the product. For example, the product can act as a proxy. As users focus their attention to different aspects of the product, in turn each aspect can induce a different emotion. Ortony (1988) summarized three aspects on which users can focus: events, agents and objects.

A product is an object it is worth noting events and agents are no less important (Desmet, 2002). Product focus are divided further into three types, which are event, agent and object. Events are the focus on anticipated or past consequences of using or owning the product. An example of an anticipated consequence is "A Rolex watch will help increase my social status". Agents are the focus of what the product represents. These may be the product; designer, company, impacts or a user group. These again can be shaped by personal experiences or can be based in society. An agent focus is linked to our standards and our expectations. An example of an agent focus is this: "I dislike smartphones that are loud, as I believe people should be discreet in public". Objects are the focus of the product itself, its visual semantics or technological qualities, and it can be linked to all concerns. An example of an object focus is "I desire an iPad as I like simple forms", which is based on an attitude of form. Not only can the product be a focus but associated products can elicit emotions. Such as, a key chain can be associated with a car model. This differs to agents as the focus is on the associated object not the representation (Desmet, 2002).

Based on the categories of product concern and focus mentioned above, nine sources of product emotion are listed in a table. This table summarizes nine kinds of user emotion elicited by products. This table could be seen as a check list for designers to brainstorm in the ideation stage or evaluate user's emotional response to a designed product in the refining stage.

Nine Sources of Product Emotion

	attitudes	goals	standards
product	Enjoying the rounded shape of the product	Desiring for owning a route navigator of a particular brand	Admiring the designer for making an innovative design
usage	Enjoying the gestures required for selecting a route	Frustrated for not being able to connect music player	Being angry with the product for not finding signal
consequence	Enjoying the sense of freedom experienced because of the device	Satisfied by being able to reach destination efficiently	Being proud of my new established flexibility

Figure 10 Nine Sources of Product Emotion (Desmet, 2007)

According to Frijda's (1994) research, any perceived change, or event, has the potential to elicit an emotion. In the case of products, the stimulus 'event' can be perceiving the product, manipulating the product, and the consequences of (manipulating) the product (Norman, 2004).

The nine sources of product emotion shown above represent combinations of the variables in Desmet's basic model. The columns represent three types of concerns, and the rows represent three types of stimuli that can evoke product emotions. The examples shown are emotional responses the author experienced in response to a newly bought car navigation system (Desmet, 2007),

2.2.7 Ideation for emotional design

After introducing the emotional theories and guidelines above, it will be easy for designers to generate a brief idea about creating a piece of emotional design. Next, emotional design rules will be introduced. Thorough analyzing of these rules also helps explain some phenomenon. For example, different people feel different emotions towards a product. A product that could elicit one emotion for all people is non-existent, so designers could only design emotional products for a group of target users who have commonalities in appraisal, concern and attitude.

People's appraisal comes from their growth environment, education experience, and working environment. Besides, biologically speaking, genes may also affect personal preference. There is no identical appraisal from two people in this world. These personal factors co-act and lead to different emotions towards a product.

Different people experience different emotions towards a given product because people differ, both in their concerns and in their product focus. Desmet (2002) also explains that the model was developed for one type of interaction and that other type's interactions of appraisals might exist. Additionally, concern types are intertwined as people's standards influence their goals and the goal influences their expectations.

Culture is one of the considerable issues that may cause different emotions. According to an article from the Association for Psychological Science (APS), research shows most people want to feel more positive than negative. Yet the emotions that cause a positive experience are shown to change between cultures, according to the APS article. Here is an example: the positive emotions that European Americans typically preferred were excitement and elation, while Chinese populations preferred calm and relaxation more. This difference is seen in media such as advertising, which utilizes the positive experience emotions to craft messages for maximum impact (Pogosyan, 2018). People from different cultural backgrounds may have different reading about the same color or form, such as the color red.

A specific emotional response is not caused by a single formal attribute such as material, shape, or color. Only when the formal attributes of an object come together to act as a medium for an emotion does an object become expressive. As mentioned, the color red is seen as a danger and also as a symbol of luck (Forlizzi, 2003).

For designers, it is necessary to seek common points on the target user they designed for. It is possible to find some basic and common rules about emotion, though there may be a big difference between the user's emotional experience in the different design projects.

Users often feel more emotionally attached to one product than another. These products have common features such as evoking user's desire, more attractive in design elements or has a personalization. Analyzing these emotionally attached products by previously mentioned theories will help designers learn how to apply emotional theory on design elements.

Emotion is an essential part of any human decision-making and planning, and the famous distinction made between reason and emotion is not as clear as it seems (Lerner, Li, Valdesolo, & Kassam, 2015). According to a study published in *Personality and Social Psychology Review*, emotion is defined as a feedback system that has an indirect influence on behavior and behavior is used to pursue (or avoid) anticipated emotional outcomes. Behaviors also provide feedback and stimulating retrospective appraisal of actions, conscious emotional states that help promote learning and alter guidelines for future behavior (Pogosyan, 2018). This may lead users to choose products to which they feel more emotionally attached.

2.2.7.1 Evoke Desire

Desire in its various forms is a strong driving factor for a consumer to want. Frijda (1986) states the essence of desire is the "…readiness to approach or bring about situations of satisfaction" (p. 283). Desmet (2002) summarized three ways to bring up desire: the desire of consequence, the desire of presence, and desire of identity.

The desire of consequence is the focus on the anticipated event of using the product which may fulfill a goal and is the appraisal of motive compliance. For example ,"The thought of playing with the kangaroo ball makes me desire to have fun" (Desmet, 2002, p. 153)

The desire of presence is the focus of the object itself, which matches an attitude of aesthetics and is the appraisal of appealingness. This can come from inherently pleasant stimuli such as bright colors and sweet tastes; as this is to appeal to our senses. For example, a consumer desires the vase for its sensual form.

The desire of identity is the focus of the products "agent" which matches a self-ideal standard or a goal and is the appraisal of legitimacy. This is seen as a 'social desire' through

personal identification with the product. Desmet (2002) states "we can 'resonate' with products as if they were somehow people" (p. 154). For example, a user may think "This jeep is as relaxed I would like to be myself."

When desire types are exerted, the user will make a purchase decision. This is because "The product resonates with what we want to be or become, want to experience our own, and want to achieve or obtain" (Desmet, 2002, p. 154).

2.2.7.2 Design attractive things

Norman (2004, pp. 17-18) cites an example of a study by Kurosu and Kashimura (1995) who investigated different ATM (automatic teller machines) layouts and discovered that the attractive ones work better. This study was also repeated by Traxtinsky (1997), who was very pessimistic about this belief. His studies, carried out in Israel, produced stronger evidence than the Japanese study. This was a conflicting cultural paradigm, as it was assumed by Traztinsky (cited in Norman 2004) that Israelis hold function higher than attractiveness.

Norman's explanation comes from the behavioral design level. Norman (2004) states: "Negative emotions kick in when there is a lack of understanding, when people feel frustrated and out of control – first uneasiness, then irritation, and, if the lack of control and understanding persists, even anger" (p. 77). Compared to "When we are happy your thought process expands, becoming more creative, more imaginative. i.e. attractive things make you feel good." (Norman, 2004, p. 19) If the user feels happy, from the appearance, they a more likely "to find solutions to the problems they encounter" (Norman, 2004, p. 19), and so they 'appear' to work better.

2.2.7.3 Personalization of a product

Personalization can be seen as a route to increase an emotional attachment with a product. "Personalization of a product's appearance positively affects the formation of an emotional bond with this product" (Mugge, 2004, p.10) In turn, this helps lengthen a product's relationship with the user, because emotional attachment to products can encourage users not to discard a product and extend the product life cycle (Desmet, 2002). For a product to become personalized, it must have the user's energy invested in the process of personalization because of product attachment relevant to the psychic energy invested in the product (Mugge, 2004).

2.2.8 Measurement of emotion in product design

Measuring emotion is also important for designers; collecting user's emotional data helps extract user's emotional needs more accurately and develop design concepts with a target. Emotional measurement method such as Kansei engineering is famous and widely used in various industrial fields.

2.2.8.1 Kansei Engineering

Kansei engineering is a product design tool or integrated manufacturing system that strives to please customers in aesthetical qualities as well as its performance. The aesthetic qualities contain product's feel, look, and smell. Kansei engineering integrates customer's psychological feelings and needs into the product design. Consequently, producers design products to bring forward those feelings and needs. In other words, Kansei engineering converts customers' Kansei into quantitative design elements.
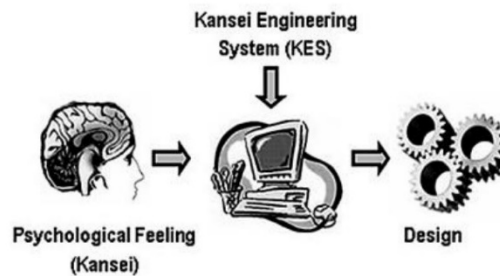
Figure 11 Principle of Kansei Engineering (Nagamachi,1989)

Here is an example to explain Kansei Engineering. When customer thinks about a sports car, adjectives such as elegant, powerful, fast, and sporty comes to their mind. Which parameters influence these impressions ? or which part of the sports car trigger these impressions? Kansei engineering shows to what extent the vehicle's suspension affects these impressions. It can do the same with the other parts of a sports car. Then, the target values of certain parts of the car can be derived. Mazda engineers used Kansei engineering in designing the model Miata, a world- famous two-seater sports car, which is known as the first and most successful project based on Kansei

Engineering (Nagamachi,1989). Designers could use Kansei engineering to obtain accurate data in the research process.

2.2.8.2 Physiological measurement

As technology develops, detecting and recording equipment of collecting emotional data has a higher degree of accuracy from more sources. For example, there are some physiological measurement methods to gather data from the human body:

- Electroencephalogram could measure and show the activity of some specific area of the brain which has a connection with specific emotional reactions.

- Electromyography could show muscular response associated with the excitability level.

- Electrodermal activity measured the activity of sweat glands, which are said to be associated with levels of arousal and excitability.

- Blood volume and pressure show the dilation of blood vessels, which is related to arousal.

- Pupil dilation is associated with arousal levels and psychological workload

- Respiration measurements may indicate negative valency or arousal levels.

Eye-tracking is one of the most famous technologies used in user interface and user experience design field for exploring and analyzing customer's attention-grabbing points (Köhler, Hler, Falk, & Schmitt, 2015).

2.2.8.3 Psychological measurement

However, high accuracy devices are not available for every designer. Compared with high precise physiological measurements, psychological measurement provides a more brief method using a Semantic Differential Scale. In 1952, Charles Osgood brought up a semantic differential scale, a less taxing method using a standardized set of bipolar adjectives on which research participant rate an issue or object. Through a series of statistical analyses, Osgood (2018) identified three recurring, stable dimensions on which people can judge nearly anything.

Democratic party

Bad __:__:__:__:__:__:_x_ Good
Cruel __:__:__:__:__:_x_:__ Kind
Unpleasant __:__:__:__:_x_:__:__ Pleasant
Unfair __:__:__:__:__:__:_x_ Fair
Dirty __:__:__:__:__:_x_:__ Clean
Negative __:__:__:__:_x_:__:__ Positive
Foolish __:__:__:__:__:__:_x_ Wise

Evaluation	Potency	Activity
Bad/good	Weak/strong	Passive/active
Cheap/expensive	Indecisive/decisive	Lazy/industrious
Foolish/wise	Soft/hard	Aimless/motivated
Ugly/beautiful	Impotent/potent	Calm/excitable
Dishonest/honest	Severe/lenient	Slow/fast
Cruel/kind	Cowardly/brave	Unemotional/emotional

Figure 12 Semantic Differential Scale (Osgood, 2018)

Researchers are suggested to build a subjective semantic differential scale (Osgood, 2018) by following the next steps:

- Researchers asked a group of participants to provide descriptive adjectives for the concept or set of concepts in which they are interested. For example, in studying people's attitudes toward the Democratic Party, researchers in this step might ask participants to come up with adjectives to describe concepts like democrat, liberal, progressive, and prochoice.
- Researchers would use the list of adjectives that the sample group produced to create a prototype semantic differential scale.
- Test this scale on a separate sample group.
- Finally, researchers would subject people's responses to the prototype scale to statistical analyses, the results of which would be used to form the final semantic differential (p. 1505).

In addition, PrEmo (Product Emotion Measurement Instrument) also provides an emotion measuring method. To measure the user's emotional response to a product, Desmet (2002) created a tool, specifically for measuring the emotions elicited for a product appearance. PrEmo is language independent and works in different cultures; it does not require extensive equipment or technical expertise, helps designers reach their goal, and refines the design.

As the picture shows below, the PrEmo user interface is comprised of seven pleasant and seven unpleasant emotions with a picture of the product in the left bottom. Each of the 14 emotions is communicated through an animated character. The participant selects one of the emotions the character displays the emotion through facial expressions, bodily movements, and a characterized sound. The participant rates the emotion on the three-point scale.

> I do not feel the emotion expressed (lower part of the scale)
>
> I somehow feel the emotion expressed (middle part of the scale)
>
> I do feel the emotion expressed (upper part of the scale)

The rating of the character is expressed as the background of the emotion. The participant can only move on to the next product once all the emotions have been rated.

"PrEmo is a non-verbal self-report instrument that measures 14 emotions that are often elicited by product design(Desmet,2003, p. 112).
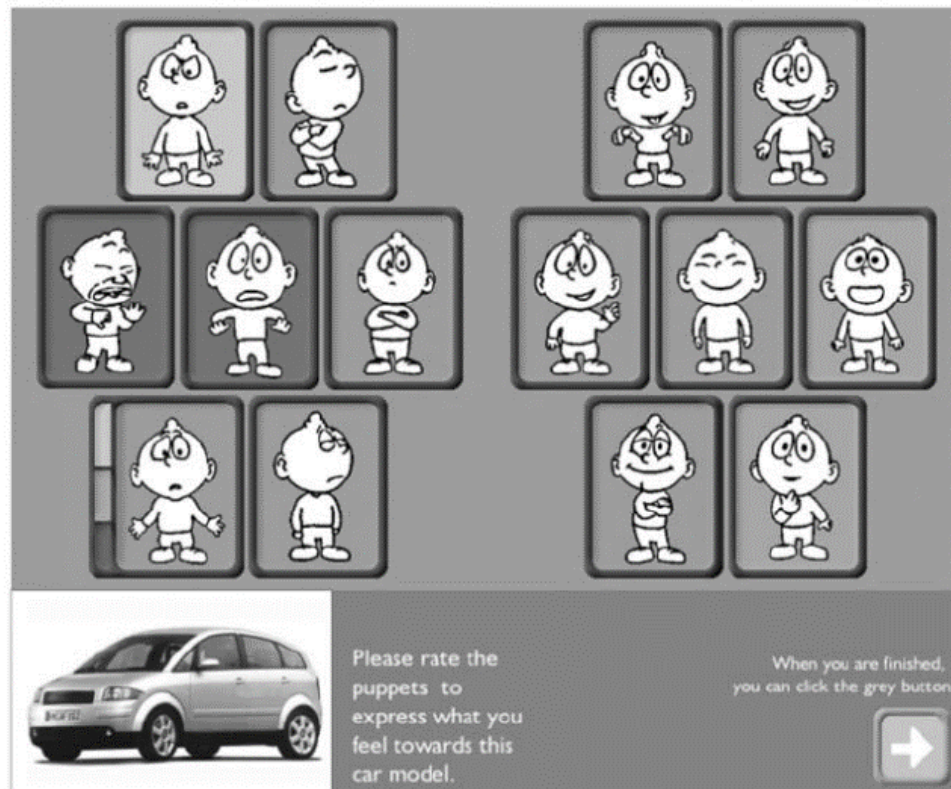
Figure 13 PrEmo (Desmet, 2003)

In summary, designers could obtain emotional data through physiological measurement and psychological measurement. Physiological measurement is more accurate because of the emotional data comes from the instrumental analysis. However, for product designers, psychological measurement is more efficient and widely used as it is low cost and time saving to screen out or guide the design direction in the early design process. In the early design stage, the designer needs a more efficient measuring method for quick design which is simple, direct, understandable, and tool-less.

2.2.8.4 Card-based design tool

A card-based design tool is provided for helping designers to summarize research insight. It is popular for its efficient and usable. Designers could use it in the whole design process. A positive emotional granularity card (PEG Card) provides for supporting emotion-driven design processes (Yoon, Desmet, & Pohlmeyer, 2013). As the figure shows below, the content of the PEG card is the participant's experience of positive emotions with precision and specific description. However, as Yoon (2016) suggested, the PEG card is an open-ended design tool, so designers could adjust layout and usage method accordingly.

Figure 14 Positive emotional granularity card (Yoon, Desmet, & Pohlmeyer, 2013)

A card-based design tool provides a low cost and efficient way to record research data or review research findings. It could be seen as design sticky notes, which the designer could us in

every design step for reminding or referencing. This practical method also shows the advantage in quick design or early-stage design.

This chapter introduces the background of emotion, emotional design theories, and emotional design thinking. Designers could find a method of emotion classification, extract emotional factors, and how to apply emotional theories in the design project. Based on the experience and achievement of forerunner in the emotional design field, systematic emotional design processes with approaches will be presented and explained in detail in the next chapter.

From a previous study, emotional products could be defined as products that evoke the user's emotional responses at the visceral level, behavioral or reflective level. Researching these products may help find design rules for emotional products.

3.1 Juicy Salif

Figure 15   Juicy Salif (Norman, 2004)

This iconic citrus squeezer could be seen as a symbol of Philippe Starck and Alessi. It is one of the most frequently quoted products in the aesthetic design and fun design field. Juicy Salif succeeds in driving customer's curiosity at first glance through its unusual form. From the visceral level, the bizarre form attracts users and evokes curiosity. After knowing it is a citrus squeezer with an alien form, user's curiosity turns to pleasantly surprised, Even though users may find the juice may spill along the three legs. The metallic surface might be damaged by the acid. It may score low on the behavioral level, but it is still a good product for users who are attracted by its unique form and just use it as a kitchen decoration. In Norman's view, Juicy Salif is not intended to be used as a juice squeezer because the visceral and reflective appeal is enough for setting it in the entrance hall proudly (Norman, 2004). Now, Juicy Salif series has extended from the classic metal design to different colors and materials, and owners use it to show design and fashion tastes which satisfy their reflective level needs.

3.2 Living Stone

Figure 16 Living stone cushion (Evolution, 2015)

Stephanie Marin designed a set of oversized pebble cushions. The soft-touch makes users feel pleasantly surprised since it is not hard as expected from its pebble form. It satisfies users from its pebble form and texture at the visceral level. The various sizes and shapes of the virgin wool pebble could be arranged according to users' requirements. It is a resting area and an enjoyable domestic game. The customization, multiple-use, comfort, and fun evoke users' pleasure from the behavioral level. The warm memory it leaves may enhance this pleasure from the reflective level.

3.3 BANG ! Lamp

BANG ! lamp represents Bitmap studio's creative and playful design aesthetic perfectly. It is the kind of the product that makes customers decide to purchase in one second after seeing it.

Figure 17 BANG! Desk Lamp (Bitmap , 2012)

It is a desk lamp equipped with a gun-shaped remote controller. Users can fire the "gun" to turn it on and the lampshade will raise up slowly. To turn the light off, simply shot it again, the light goes out and the lampshade knocks to the side, showing that it's been hit. The BANG! lamp absolutely brings an innovative user experience to turn on/ off a lamp and brings fun in the usage. Though the form and color of the lamp follow the most common design in the visceral level, it still brings a pleasant surprise after knowing how to use it and joyful during use.

3.4 Breathing Chair

Breathing Chair offer a high comfortability to user through sponge form. It is made of thermoplastic polyurethane foam, having some regular triangle holes in it and looking like it is about to breathe. The professionally calculated holes are spaced out through the three layers of foam plastic. It is designed to compress into the shape of an armchair when the user sits in it and spring back into a cube when the user stands up. The shape-shifting process looks like a breathing process.

This perforated foam chair can transform its shape according to the body of the sitter and provides an extremely high comfortability for the user. The sponge form and shape-shifting process brings joyful in the visceral level, and the high comfort satisfies a behavioral level need.
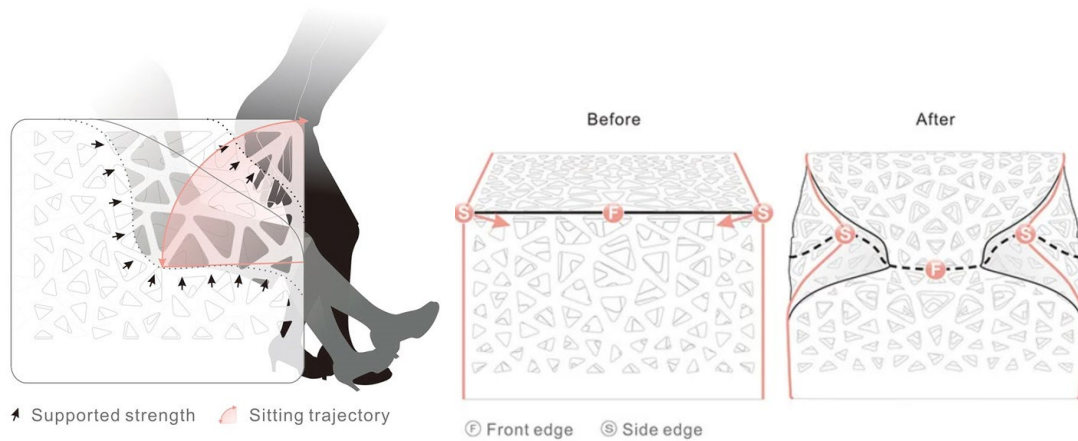
Figure 18 Breathing Chair (Melanson, 2020)

3.5 Happily Ever

      Happily ever is a chair and dog house combination. It is a piece of common furniture for pet owner to share with the pet that satisfies the need for intimacy between pet and the pet's owner. It has two seats, the lower one and the upper one. It could be used in several ways as the owner sitting on the chair, the pet could sit under the chair. There is a hole for pets to play with owners. It is designed to provide a heartwarming experience for the owner to pat the dog when it comes near. This chair brings aesthetics at the visceral level and fun in the behavirol level. The most attractive point for the user is the joyfulness at the reflective level. It is unique and has special meaning for each user.

Figure 19 Happily ever Dog house & stool   (Kim, 2013).

3.6 Tobacco Package Design

Figure 20 Winefeild cigarette packages (The Royal Australian College of General Practitioners, 2018)

A series of graphic warnings on Winfield cigarette packages are designed to evoke unpleasant emotions. These packages are designed simply with an enlarged picture of ulcerated skin or damaged organ in the center. These package designs are designed to make the user feel disgusted or fearful at first glance. These packages try to warn the user of the risks they may take before purchase. The pictures of blindness, gangrene, and heart disease may alarm users at the reflective level. It is more than the physical torture; users may think of their family and responsibility. The unpleasant emotion evoked in visceral and reflective level may help users reconsider their purchase decision.

3.7 After the rain

　　Japanese designer Aya Kishi provides a new idea for tombstone design. This untraditional tombstones incorporate a series of optical prisms into the centers and creates a spectrum of light on the ground. The natural rainbow effect weakens the pain and suffering after losing a loved one in the behavioral level. The more important meaning is the inspiration it brings in the reflective level. It re-interprets death. It tries to express death may not be a thing full of sorrow. It tells the user about the future, hope and tomorrow through the rainbow.
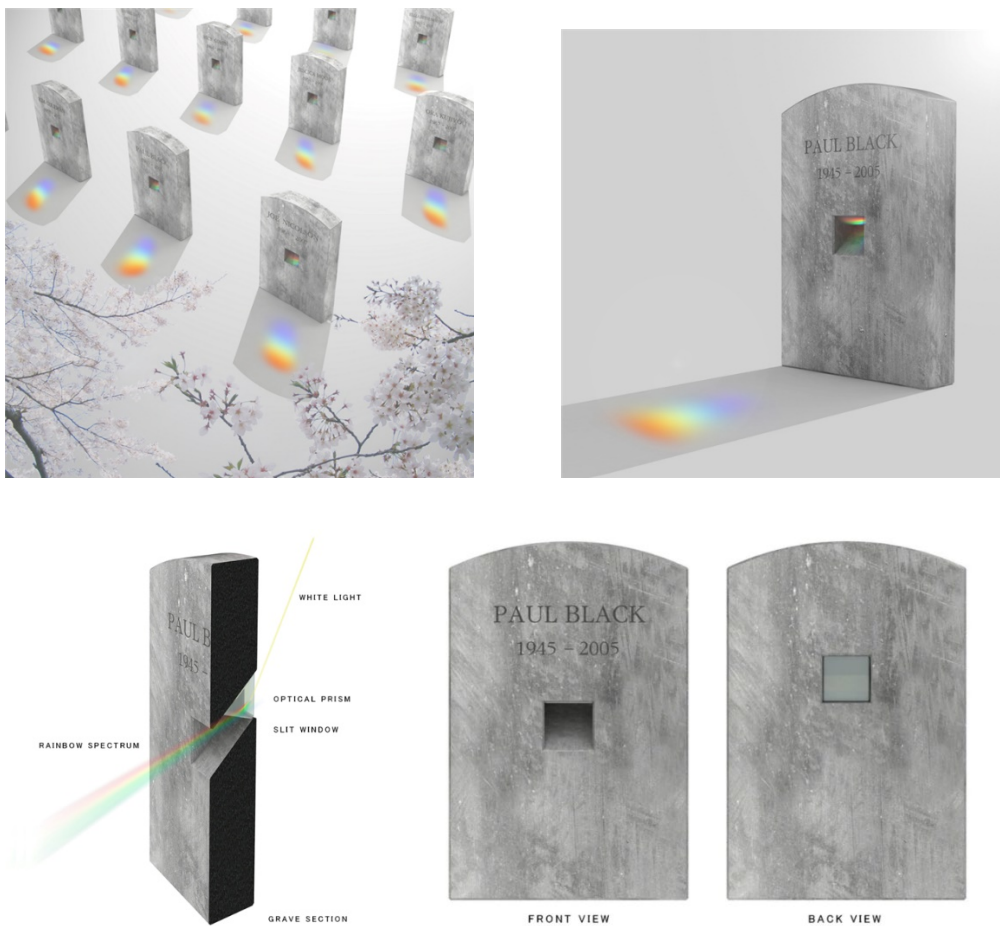
Figure 21 After the rain (Aya Kishi , 2013)

3.8 Meltdown lamp design

     Meltdown series lighting is inspired by the Fukushima nuclear accident. It has the floor lamp, hanging lamp, and table lamp with different color options. Designer Johan Linderstan (2013) said " Meltdown is an interpretation and attempts to make something beautiful from the disastrous nuclear accident in Fukushima. Would an actual meltdown occur and what would the impact be? The disaster is reflected in the lamps where the process already began and the bulb is about to melt through the last defense of the glass."　The melancholy it brings in the reflective level is more mentionable compared with the illumination function and beautiful color scheme.

Figure 22　　Meltdown lamp (Lindstén, 2013)

3.9 Orbital plate
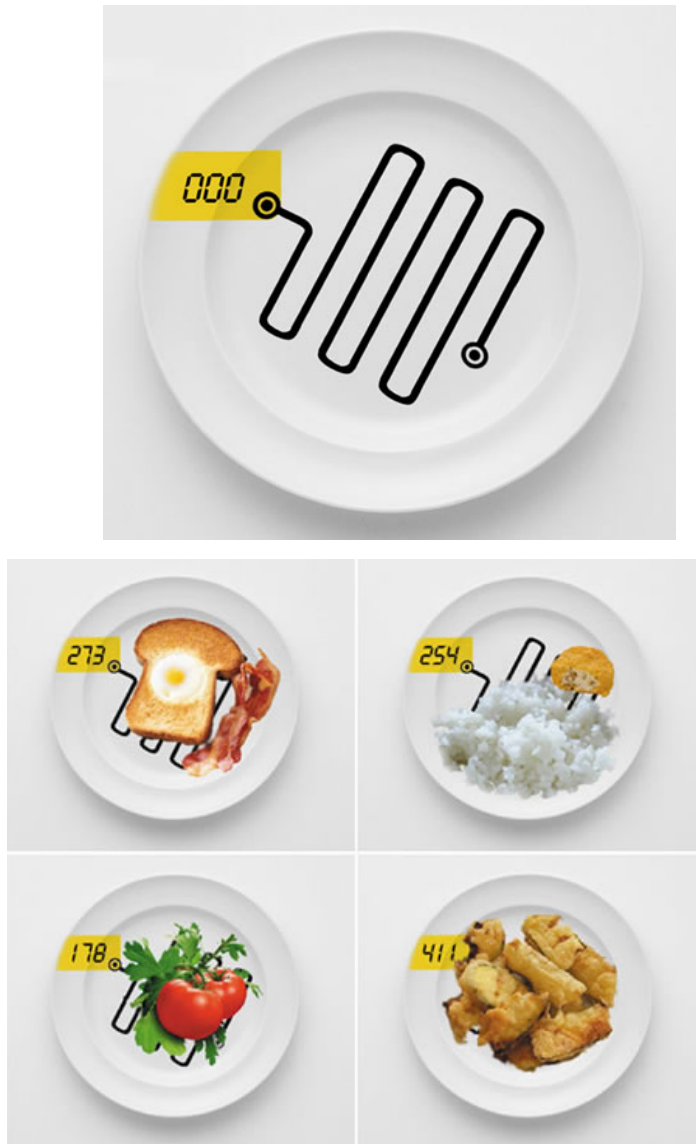
Figure 23   Orbital Plate ("Orbital Plate," 2011)

Orbital is a Calorie-Calculating Plate designed by Roni Paslah. The plate is able to measure the calories of the food it hold. This concept is designed to restrain the greedy or evoke user's guilt in the behavioral level. When users hold excess food, or have bulimia or binge eating disorder, the number on the plate is a reminder for users.

3.10 Christain Louboutin lipstick package

Figure 24　Rouge Louboutin Velvet Matte (Christian Louboutin website, 2020)

　　This Christian Louboutin lipstick has a beautiful metal vial shaped body and crown-like cap. The precious package is designed to evoke customer's fascination from the visceral level. The dulcet "click" sound when capping it shows the unique quality and this satisfies users in a behavioral level. The queen's scepter form evokes a proud and confident self-image in the reflective level. The commercial advertising strategy and high pricing both work on customers' reflective level to make it beocme a symbol of beauty, fashion, and wealth.

There is a table to summarize these emotional design products.
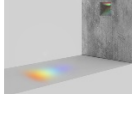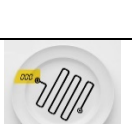
Product	Target emotion	Emotional level	Designi factors	Picture
Juicy Salif	Curious	Visceral	Form	
Living Stone	Joyful	Visceral Behavioral	Form Material Fucntion	
BANG! Lamp	Amused	Behavioral	Function	
Breathing Chair	Satisfied	Behavioral	Form comfort Material	
Happily Ever	Joyful	Behavioral	Form Funciton	
Tobacco package	Alarmed	Visceral Relfective	Pattern	
Afther the rain	Inspiring	Reflective	Function Form	
Meltdown	Melancholy	Reflective	Form	
Orbital	Guilty	Behavioral	Function	
Lipstick package	Confident	Reflective	Form	

Table 1 product analysis

In summary, these ten products are selected from diverse categories with distinct product features through different combinations of color, material, form, or function.

Both positive and negative emotions could be evoked in the three levels; visceral, behavioral, and reflective. There is not a limitation for negative emotion's evocation. Inversely, evoking negative emotions is more functional for warning.

Since these products are all designed for people, there are a series of emotional responses during the user experience process even though some of these emotions are imperceptible neutral emotion. Products may evoke several emotions at the same time. If these products are designed to solve a problem for a group of the target user, and these emotions are qualified, if there are one or two stronger emotional responses that contribute more to solve the problem than others, the stronger response could be seen as the representative emotion. This main emotional response is for designers to focus on. Secondary emotions may influence the evaluation of a product.

In order to trigger the target emotion, the design factors in corresponding level such as form, color, material, pattern, or function, operation method, or implication have been carefully considered according to target user research. Even though there are color theory or material research showing emotion meaning behind color and material, the evoked emotion is still uncertain after combining certain colors with the shape or applying this color into different products. But in fact, the design should be an endless process; designers could always adjust design solutions until they find the right combination to evoke the target emotion. A logical design thinking and quantitive measuring standard is needed to help designers evaluate their design.
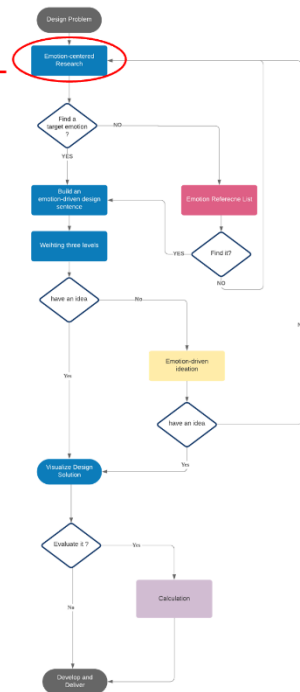
Chapter 4 Design Approach

By analyzing the ten products in the last chapter, it is summarized that at least one user emotional response should be evoked in visceral, behavioral, or reflective level by emotional design product. Thus, in order to help designers add emotional thinking in product design and make it an emotional design product, an emotion-based design process and emotional design methods will be introduced in this chapter.

Through a previous study, emotional design is an auxiliary tool for helping solve the design problems. The emotional design should still follow the basic user-centered design process: discover the potential for emotion trigger, define the emotion, develop a solution, and deliver and evaluate. Here are six process of emotional design will be discussed in this chapter. This six design process could be mapped to an emotional design diagram.

4.1 Emotion-centered research

Emotion-centered Research – – – – – – – – – – – – – – –

Purpose: Find user's emotional need.
         Focus on user's attitude, goal and standard, knowledge and expectation.

Suggestion: PDD research + User Emotion Card

How: Immersing.
         Storytelling.
         Find User's emotion variety.
         Collecting research information.
         Make a set of user emotion card.

First, in the background research stage, designers should focus on user emotion collection and find a potential for emotion triggers. According to a previous study on PDD approach, which is a method helps designers gain an insight into user's attitudes, aspirations, and values. there are five overlapping steps could be used in emotional design research to get user emotion card.

1. Immersing into the users's lives. Designers should try best to collect information from users living surroundings, lifestyles, habits, social relations and education, and experience to realize users; attitudes, aspirations, and values. This may help designers find new information even the user does not notice.

2. Storytelling users' experience through stories. Designers can realize the meaning of the problem or product through users' stories and experiences. This may help designers understand what appeals to users motivation, legitimacy, and novelty further.

3. Observing users' emotion variety around the problem. Designers should find and record a series of emotional responses and triggers during the process as users talk about the problem or deal with the problem.

4. Collecting key information from previous steps and analyzing the emotional response behind data, recording research information on separate emotion cards. Each card contains only one piece of information and emotion behind it. The information on the card should be simple, concise, and understandable. These cards will help designers to brainstorm and find the potential to trigger target emotions later.
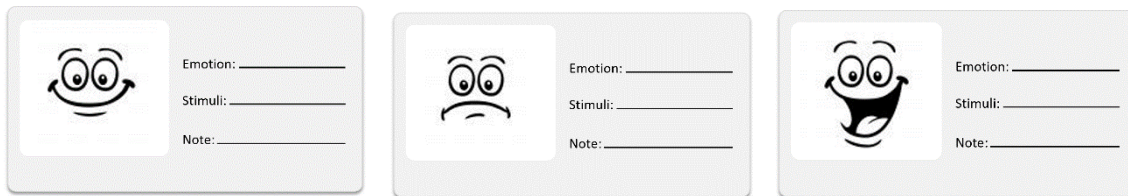

Figure 25 user emotion card

The designer cloud mark useful information such as the intensity of emotion in the note column. And the layout of the user emotion card could be adjusted accordingly.

4.2 Screening out the target emotion

Target Emotion Screening

Purpose: Find the target trigger emotion.

Suggestion: Designer find the target emotion form Desmet's emotion source
table or Plutchiks' Emotion wheel.

Product Emotion Source Table could be used for analyzing.

How : Analyzing user emotional research.

Find design potentials for triggering emotion.

Narrow down / expending target emotion to be triggered.
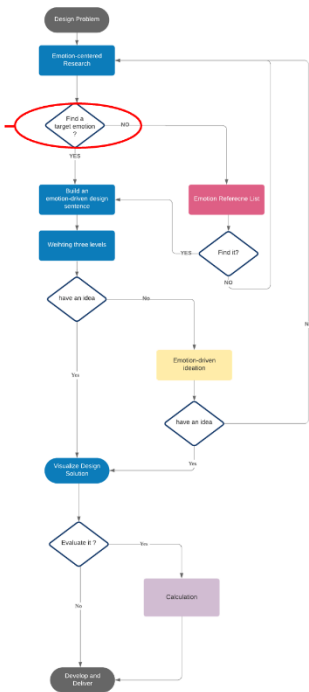
Secondly, screening out the target emotion.

In this stage, a target emotion needs to screen out. The users' emotional information obtained from previous steps may vague and uncertain. After analyzing the emotion cards, the designer selects one emotion to be most effective. This emotion is selected according to the designer's research and judgment in previous steps.

For helping to select emotions, an emotion checklist based on Pilchuck's (2002) emotion theory could be referenced.

Figure 2 Emotion Wheel (Plutchik, 2020)

If the emotion is clear and basic and the designer has ideas about how to apply it according to his research, they can jump to the next step, ideation.

If the emotion is complex and uncertain and the designer has no clue about selecting target emotion and applying it. a summarized emotion source table could be used for assisting brainstorming. According to the previous study on Desmet's emotion producing model, user's appraisal on a product is influenced by attitude, goal, standard, knowledge, and expectation. Based on Jordan's pleasure model, it could be inferred that each emotion should be further defined as physiological emotion, psychological emotion, ideological emotion, and social emotion.

This table helps sort the user's emotion according to human's four concern types as the four columns show. It also sorts emotion according to emotion levels as the four rows show. Mapping user's each concern to each emotion reaction level, 16 emotions about one product happened in different levels.

	Attitude	Goal	Standard
Visceral			
Behavioral			
Reflective			

Table 2 Emotion source table

This table helps designer to split some complex and indescribable emotion. Sometimes it is difficult to extract user's emotion because the user has a conflict and indescribable emotion in their own. It is hard for a user to describe their emotion on a product since the appraisal comes from various aspects of products. For example, a person plans to buy dishes that are durable after

breaking the last plat accidentally. However, a china dish with a delicate gold pattern attracts his or her eyes, a complex emotion produced at the moment. From a physiological - attitude view, he or she is so fascinated by the delicate appearance and fine detail. From psychological - goal view, it is not satisfying the " not easily broken" appeal. The conflict makes the consumer feels satisfied with the plates, but not really. The salesperson recommends another plastic plate that also has a delicate pattern. The dish evokes a satisfying emotion in both physiological - attitude and psychological – goal. The complete satisfied emotion contributes to the purchase decision.

From the designer's side, using this table to figure out the user's emotional ingredients will help the design objective be more specific and the design process be more targeted.

From the previous step, if the weighting factor for the visceral level is larger, it is suggested to focus on the four emotion types in the first row. If the weighting factor for the behavioral level is larger, it is suggested to focus more on emotions in the second row. If the weighting factor for reflective level is larger, it is suggested to focus more emotions in the last second row.

There is not a strict rule of which grid should be selected as a design objective in this table. Designers could select grids according to project requirements or product categories.
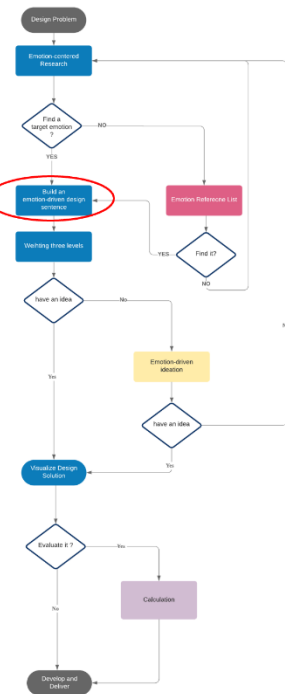
4.3 Design sentence

Build a Design Sentence

Purpose: Summary design goal from preceding emotional research and following design direction.

Suggestion: Design … for … to … through evoking …

How: Put design object, target user, design goal and target emotion into a sentence.

The next step is problem defining or design brief summarizes the previous research.

From the last two steps, the designer should summarize a design sentence contains the target user, product category, emotion to be evoked, and final design purpose. In this design sentence, the role of the emotion to be evoked is the key point to help distinguish an emotional product from other user-centered design products.

An example of the suggested design sentence is :

Design _____ for _____ through evoking _____ to solve _____ achieve _____ effect.

The design sentence will help summarize the key information from previous research and set a design objective for the following ideation part.

4.4 Weighting design factors

Weighting -

Purpose: Analyzing possible design factors form three emotional design levels.

Help designers guide design direction.

Works for final evaluation.

Approach: Weighting design product in a three emotional level's table.

How : Visceral level + Behavioral level + Reflective level = 100%.

Assign a value to each emotional level according to the product categories or design object.

Visceral level	A%
Behavioral level	B%
Reflective Level	C%

A % + B% +C% =100%

After that, find the main emotional response level and weight the emotional levels according to a product category or design requirement.

According to Norman (2004), there are three levels: visceral, behavioral, and reflective for emotional design product to act on. However, there are various products in different categories and design goals are different. For example, the design focus of decorative products that may focus on aesthetic and hand tool products may focus on function and usability. When users appraise these two products, the product category affects users' opinions. For a decorative product, users more often appraise it from the visceral level although it evokes emotion in behavioral and reflective levels. However, for hand tool products, users may appraise it from the behavioral level. Weighting these three levels according to product categories will help evaluation be more accurate and objective.

For example, according to the percentage system, the sum weighing of visceral, behavioral and reflective level is 100%. If the design goal is a hand tool, the behavioral level will be weighed over 50% and the visceral level may take second place and weighed 40%, and the reflective level weighed 10%. The weighting value needs to be adjusted according to different design requirements.

Finding the emotional response level and weighing three levels will also help designers to find target emotions in the early design stage.

Visceral level	a %
Behavioral level	b %
Reflective level	c %

Table 3 Weighting

$$a\% + b\% + c\% = 100\%$$

4.5 Ideation

Ideation -

Purpose: To visualize emotion-driven design solutions.

Suggestion: Fill in the design factors table.

How: 5.1 List design factors that may help evoke target emotion.

5.2 Research emotion driven design factors.

5.3 Update the list of design factors.

5.4 Visualize design solution through Sketch / CAD   Model / Physical Model.
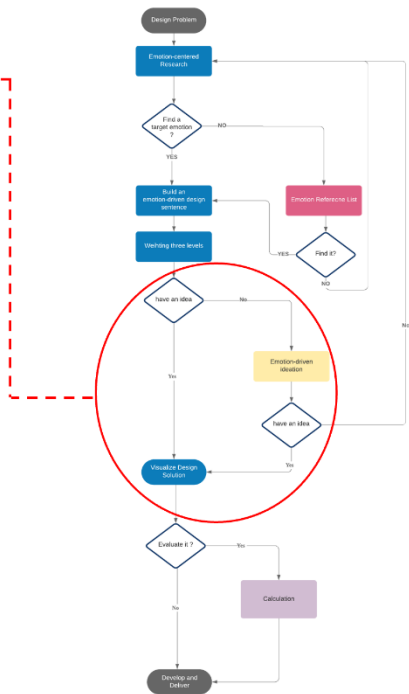
The ideation stage is divided into three parts; designers should list design factors, and research the relationship between target emotion and design factors, then combine researched design factors to create the concept and visualize their ideas.

First, designers should list design factors according to the target user research and get a table with the weighting value from last step. Designers should consider how many design factors a concepts supposed to have such as how color contributes to evoking emotion, how product form will affect user emotion, material selection, and function design. Design factors are dependent on each project; they should not limit to the above-mentioned elements. Classify these design factors into three levels. The classification standard follows Norman's theory: design factors related to product appearance belongs to visceral, design factors influencing usage belong to behavioral, design factors influencing self-awareness, memory, and social lives belongs to reflective.

In this step, designers are able to get a table like this:

Visceral level (a%)	Design factor A Color
	Design factor B Size
	Design factor C Material
Behavioral level (b%)	Design factor D Function
	Design factor E Button
Reflective level (c %)	Design factor F Memory

Table 4 List of design factors

Next, designers should research the relationship between target emotion and each design factors, Each design solution should contain a list of design factors. The ideation of emotional design products should focus on evoking emotions in order to generate various design ideas specifically. User emotion cards collected from the first step could be used here for brainstorming.

There is a research example of different design factors influencing the evoking of emotions. If design factors are color, shape and material selection, research on relationships between color and emotion, shape and emotion, material and emotion should be used.

- Color and emotion:

Color	Positive trait	Negative trait	Emotion
Red	enthusiasm	rage	anger
Orange	pride	disgrace	shame
Yellow	awareness	panic	fear
Green	satisfaction	hoarding	greed
Blue	clarity	racing	confusion
Purple	leadership	impotence	power

Table 26 Color codification of emotions(Nijdam,2005)   Table 5 Color table summary (Nijdam,2005)

- Material and emotion :
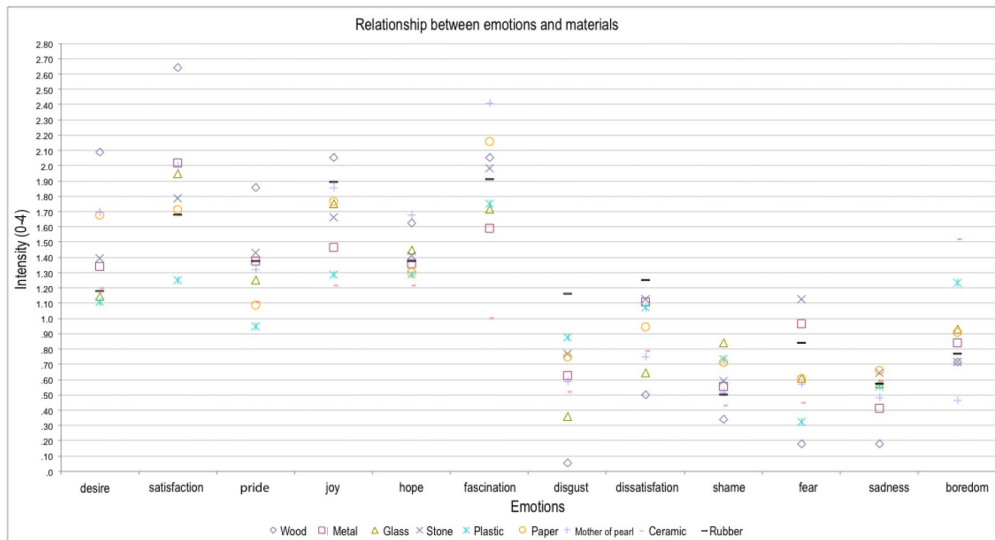
Table 6 Material selection and Emotion (Crippa, & Rognoli, & Levi, 2012)

Designer cloud search relationship between target emotion and design factor accordingly. Combining researched design factors and create design concepts. Get a updated design factors table of each concepts.

Visceral level	Design factor A Color	Red
(a%)	Design factor B Size	Small
	Design factor C Material	Silicone
Behavioral level	Design factor D Function	Ease of use
(b%)	Design factor E Button	Fun
Reflective level (c %)	Design factor F Memory	Warm memory

Table 7 Update design factors

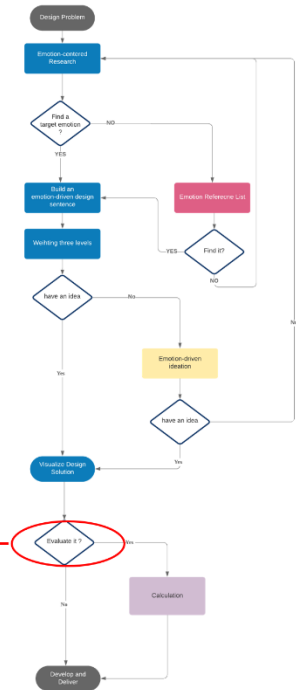Then, visualize design concepts. Designers could use sketches, CAD models, or prototypes to visualize their ideas and design solutions.

4.6 Evaluation

Evaluation

Purpose: Help evaluate a design solution.
It could be used for comparing, developing or analyzing design solutions.

Suggestions : Refer to the Emotion Source Table.

How: Calculation : grade design solution in the three levels.

Calculation

Purpose: Analyze an emotional design solution quantitively.

How:

	Attitude	Goal	Standard
Visceral	Interest		
Behavioral			Satisfied
Reflective		Acceptance	

Sum = A % (Visceral score) + B% (Behavioral score) + C% (Reflective Score)

In the step 4, the product has been weighted in the three levels, each level should have a weighting value.
In the evaluation step, the final design solution will be grade at those three levels.
For example, if the designer thinks the final design evoke "interest" partly, designer could grade it 40 % or 50 % accordingly, and times the weighting value.

After getting various design solutions, a calculation method could be used for evaluating design solutions. This calculation method needs the list of design factors and emotion source tables from previous steps.
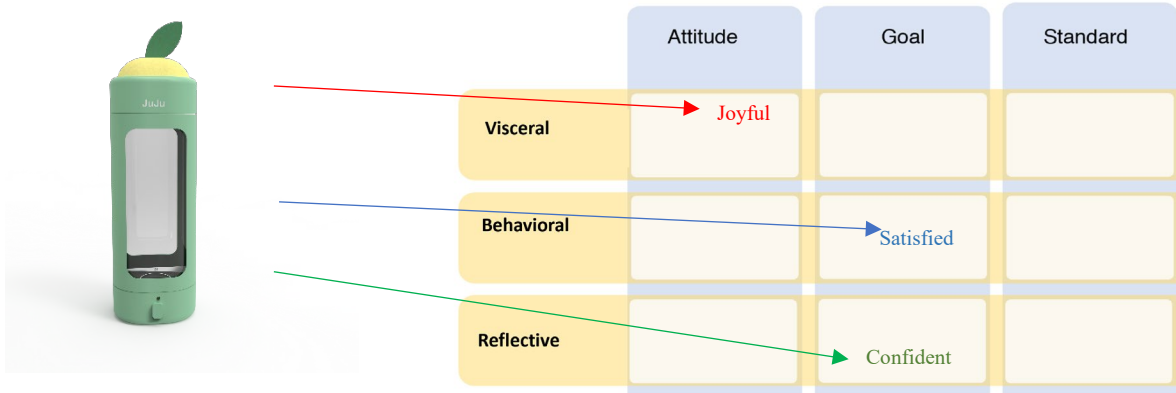

Table 9 Emotion source table

Visceral level (a%)	score in the visceral level 80%
Behavioral level (b%)	score in the visceral level 60%
Reflective level (c%)	score in the visceral level 70%

Designer grade the design solution in the visceral level, the value should between 0% ~100%.

Designer grade the design solution in the behavioral level, the value should between 0% ~100%.

Designer grade the design solution in the reflective level, the value should between 0% ~100%.

Table 10   Calculation table for solution 1

Designer could use emotional scale to rate the design solution at each emotional level.

Figure 40 Emotion scale

	Attitude	Goal	Standard
Visceral	Joyful		
Behavioral		Satisfied	
Reflective			Confident

A % (Visceral score)

+

B% (Behavioral score)

+

C% (Reflective Score)

= Sum
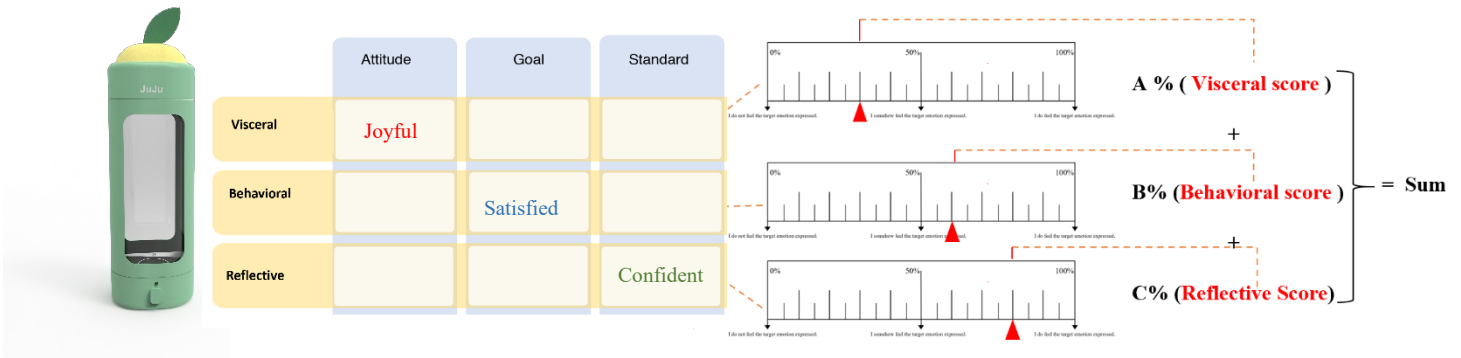
Sum = A%(Visceral score) + B% (Behavioral score) + C% (Reflective score)

For example, if the designer think the solution could evoke emotion "joyful" in table 9, he or she could score this design solution from 0% to 100% accordingly. And then, this score times the weighting value for this emotional level, the value is the score for the design solution at this emotional level. The behavioral and Reflective level also be calculated according to this theory. Adding these three scores up to get a sum value of the design solution.

Designers could evaluate one solution in these three levels according to the sum value at each level. This method could also be used to compare two or three solutions.

Chapter 5

In Chapter 4, a flowchart shows the design approaches in each design phase of emotional design. In this chapter, an emotional design project will demonstrate the design tool in Chapter 3 further.
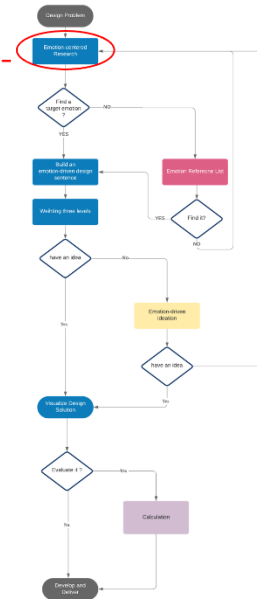
5.1 research

This section will start from the design problem: Lily is young girl who likes to eat fast food and order takeout. A set of tableware designed for target user Lily is meant to encourage her cooking and eating at home. According to the emotional design tool in Chapter 3, the first step is user research and analysis through five steps: immersing, storytelling, observing, collecting information and emotion card making. The purpose of the user research is to find the target user's emotion cards and product concerns.

Immersing: In this steps, interviews, photographs and video recordings are used to restore the living environment of the target user. And designers should collect information from user's surroundings, lifestyles, habits, social relations and education, experience and other information.
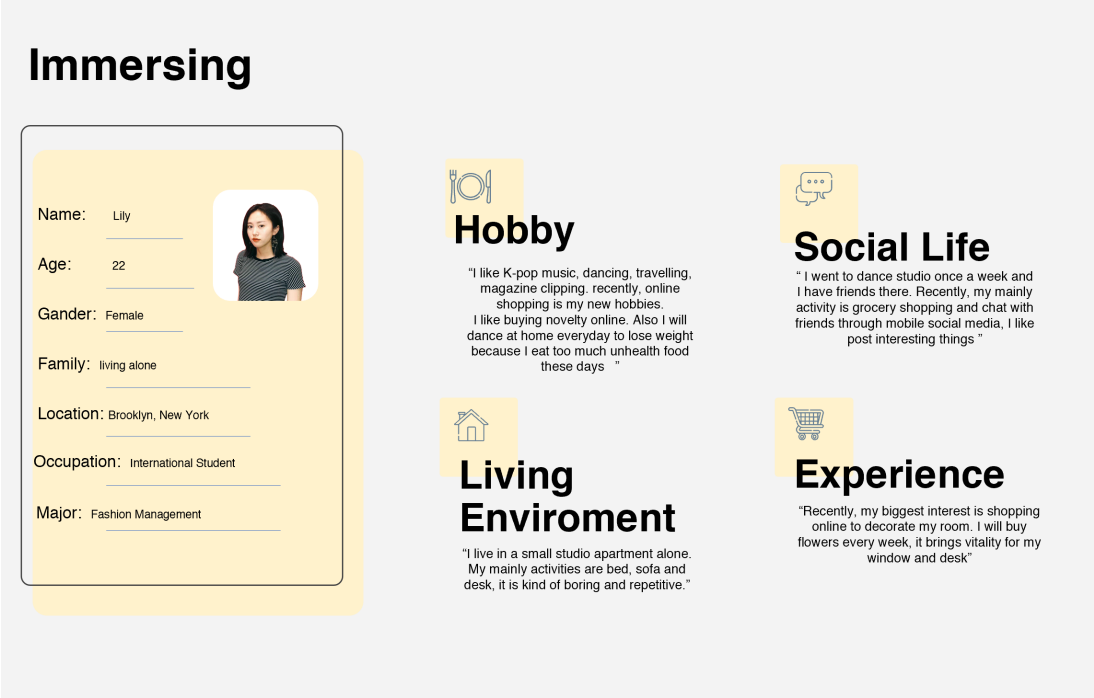
Immersing

Name: Lily

Age: 22

Gander: Female

Family: living alone

Location: Brooklyn, New York

Occupation: International Student

Major: Fashion Management

Hobby

"I like K-pop music, dancing, travelling, magazine clipping. recently, online shopping is my new hobbies.
I like buying novelty online. Also I will dance at home everyday to lose weight because I eat too much unhealth food these days"

Social Life

" I went to dance studio once a week and I have friends there. Recently, my mainly activity is grocery shopping and chat with friends through mobile social media, I like post interesting things "

Living Enviroment

"I live in a small studio apartment alone. My mainly activities are bed, sofa and desk, it is kind of boring and repetitive."

Experience

"Recently, my biggest interest is shopping online to decorate my room. I will buy flowers every week, it brings vitality for my window and desk"

Figure 27 User emotion research

Storytelling: According to the timeline, Lily's daily activity is organized into two storyboards. The first storyboard shows her eating activities that use tableware regularly. The second board contains daily activities for which she may use tableware occasionally. A plate, bowl, mug, spoon, and chopsticks are the most frequently used tableware for the target user.
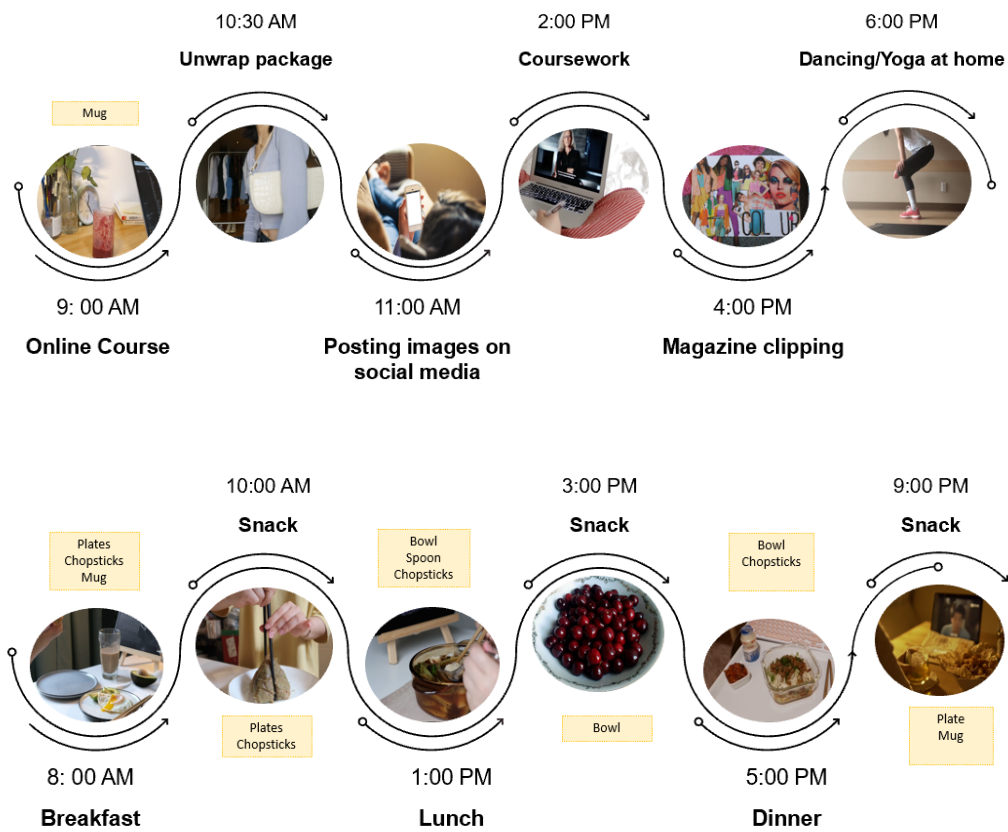
Figure 28 User emotion Storyboard

The research shows user's standard of tableware: A set of tableware should contain a plate, bowl, mug, spoon and chopsticks.

Emotion variety: There are a series of emotions when she is using the tableware. Eating healthy food and posting breakfast gives Lily satisfaction, but the unpleasant emotion occurs when she is losing control of eating fruit and night snacks, eating alone and in a boring environment. Similar to Desmet's PrEmo, there is a series of facial expression icons combined with an emotion and specification records user's emotion variety.
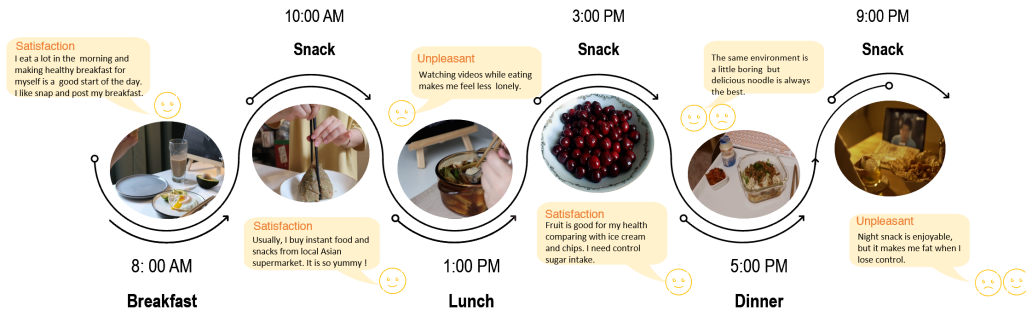
Figure 29 User emotion variety

Collecting information:

From the research, the user's emotions related to tableware could be described with pleasant degree and intense degree, it could tell cooking and posting food triggers pleasant feelings and overeating triggers unpleasant emotion. Eating lunch alone triggers slightly unpleasant.

Emotion card:

Form the daily life interview, the vitality of plant triggers pleasant feelings. Posting pictures in social media triggers pleasant emotion. Form previous analysis, a set of emotion card records 3 unpleasant emotions and 3 pleasant emotions of Lily; the emotion cards also show stimuli and designer's notes of each emotion.

Figure 30 User emotion cards

Form the user research, user's four types of concerns regarding tableware could be recorded briefly :

Attitude	Simple design and looking clean, small and light.
Standards	Contains plate, bowl, mug, spoon and chopsticks.
Goals	Contains small amount of food to help lose weight.
Knowledge and expectation	Brings vitality.

Table 11 Four types of concerns

5.2 Emotion screening

Target Emotion Screening

Purpose: Find the target trigger emotion.

Suggestion: Designer find the target emotion form Desmet's emotion source table or Plutchiks' Emotion wheel.

Product Emotion Source Table could be used for analyzing.

How : Analyzing user emotional research.

Find design potentials for triggering emotion.

Narrow down / expending target emotion to be triggered.
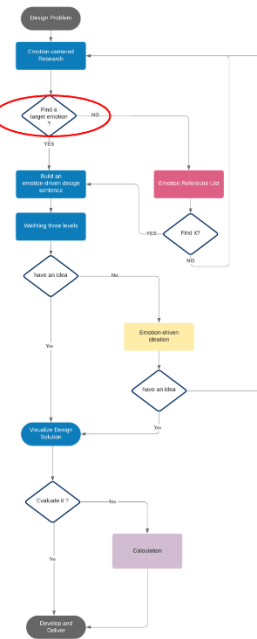
From the user research, "interest" might be a good starting point for design direction. Through the emotion wheel, it is a pleasant emotion and the quality of emotion is between joy and anger. The intensity is lower than anticipation. The emotion analyzed is essential for design factor's ideation and research since it is not easy to find relationship between color and interest. In this situation, color that evokes anticipation or joy is also helpful for evoking the emotion "interest".
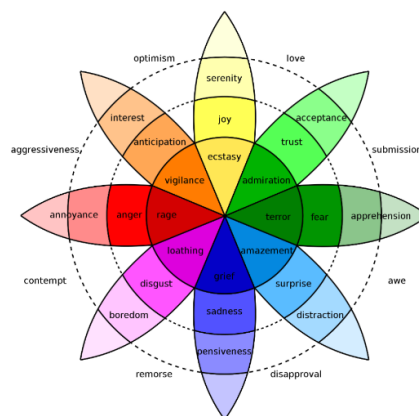
Table 3 Emotion Wheel (Plutchik, 2002)

Here is a product emotion source table for target user :

	Attitude	Goal	Standard
Visceral	Interest		
Behavioral		Acceptance	
Reflective			Optimism

Table 12 Product emotion source

5.3 Design sentence

Build a Design Sentence

Purpose: Summary design goal from preceding emotional research and following design direction.

Suggestion: Design … for … to … through evoking …

How: Put design object, target user, design goal and target emotion into a sentence.
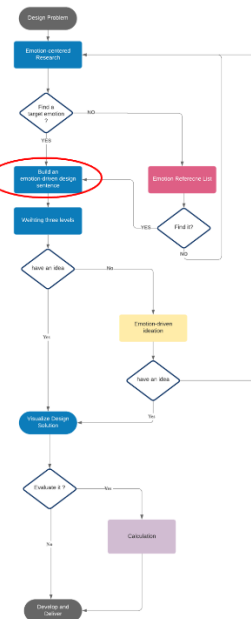
Design a set of tableware that contains plate, bowl, mug, spoon and chopsticks for Lily through evoking "interest" in the visceral level, "acceptance" in the behavioral and "optimism" in the reflective level to encourage the user to cook and eat at home. This design sentence

summarizes the design objects with emotional details, it reminds the designer of the following research, and ideation direction will be towards to the target emotion.

5.4 Weighting
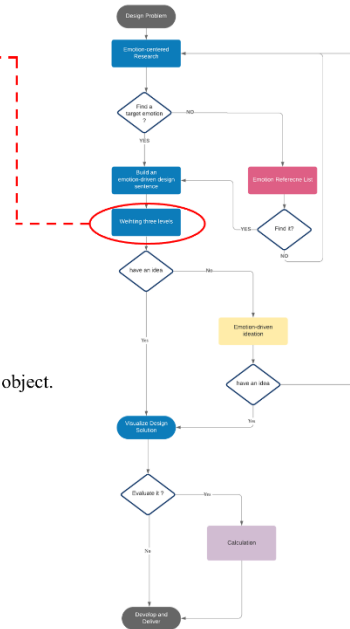
Through marketing research on tableware, user's emotional responses on a tableware are mainly influenced by visceral level design, thus, it has the highest weighting 50%. Behavioral level takes the second place. Reflective level could evoke interesting emotion rarely. By weighting emotional levels, the following steps such as selecting design factors and ideation will be more directive. It also provides a more reasonable standard for evaluating emotional design product.

Visceral:	50 %
Behavioral	40 %
Reflective	10 %

Table 13 Weighting table

5.5 Design factors

Ideation ---------------------------------

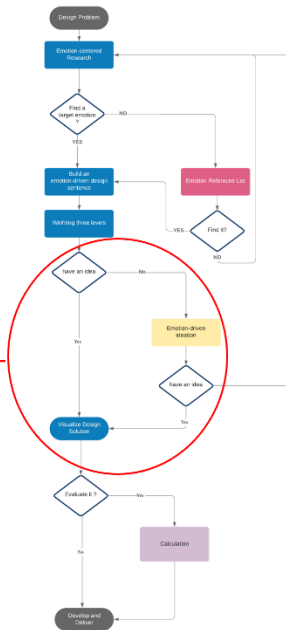**Purpose:** To visualize emotion-driven design solutions.

Suggestion: Fill in the design factors table.

How: 5.1 List design factors that may help evoke target emotion.

5.2 Research emotion driven design factors.

5.3 Update the list of design factors.

5.4 Visualize design solution through Sketch / CAD   Model / Physical Model.

According to Xue's (2019) thesis on tableware design (*Tableware Design according to the Physical Environment*), shape, color, material, texture and pattern are the main factors influencing tableware design. The balance and repetition between these factors also need to be considered.

| Visceral 50%	Shape
	Color
	Material
	Texture
	Pattern
Behavioral 40%	Functionality
	Fun of use
Reflective 10%	Brand

Table 14 design factors

5.6 Ideation

Evaluation

Purpose: Help evaluate a design solution.
It could be used for comparing, developing or analyzing design solutions.

Suggestions : Refer to the Emotion Source Table.

How: Calculation : grade design solution in the three levels.
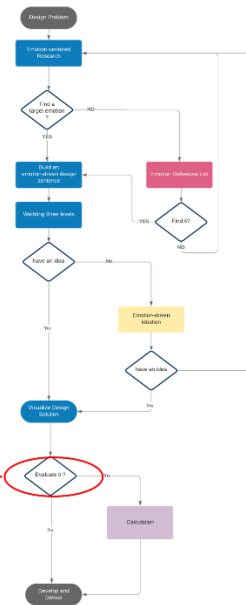
Ideation part has two steps; the first step is to find the relationship between design factors and the target emotion. The second step is to visualize the different combination of the emotion-driven design factors.

5.6.1 Research

Research : According to the last step, design factors shape, color, material, texture and pattern will be the main research direction. Shape of the tableware relates to roundness, complexity and curves. There is are series of experiments in Lu's report (2012) (*On Shape and the Computability of Emotions*) that provide data which explain the relationship between emotion and shape. Roundness: The relationship between emotion and shape could be confirmed according to the fact that curved contours lead to positive feelings and that sharp transitions in contours trigger a negative bias. Complexity of shapes: Humans visually prefer simplicity. Complexity is subjective to individuals, but parsimony and orderliness are still decisive factors influencing the simplicity of a product's appearance. Using the minimalistic structures is the simplest way of organizing these structures in a product. Curves: Positive images defined by human have more curves with 60% - 100% fitness to ellipses and a higher average curve count. Color: According to color psychology, beige evokes boredom more frequently. Yellow, orange and green evoke more positive emotions and vitality.

Material: According to the material, ceramic and plastic are two materials that evoke boredom. Rubber and metal score lower for evoking boredom. Though mother of pearl is the last material to evoke boredom, the material will restrict other design factors such as color and form. The wood and rubber are most likely to evoke positive emotion such as satisfaction and joy.
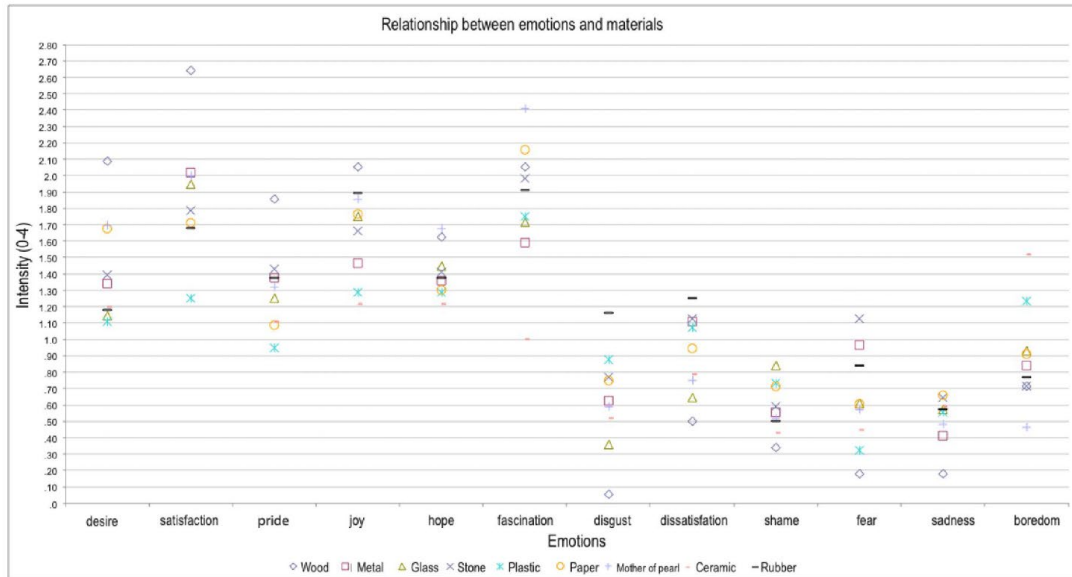

Table 8 Material selection and Emotion (Crippa, & Rognoli, & Levi, 2012)

Texture and patten: Textures used in tableware are limited, so pattern and texture are more often used for work with the material. According to Paschke's (2000) relationship of texture with emotion, rough textures are more attractive and frequently used for emulating the natural aspects of the earth and make people feel more at ease and conformable. But rough textures will overshadow the other design elements like form and color. Smooth texture are more unobtrusive and allows showcasing of other elements.

After realizing the relationship between emotion and each design factors, the second step of ideation is to list the possible combinations of the emotion-driven design factors:

According to the previous research on design factors, several combinations are listed below:

Solution 1:

Visceral 50%	Shape	Streamlined
	Color	Warm
	Material	Metal
	Texture	None
	Pattern	None
Behavioral 40%	Functionality	Small volume
	Fun of use	None
Reflective 10%	Brand	None

Table 15 solution 1's design factors

Solution 2 :

Visceral 50%	Shape	Streamlined
	Color	None
	Material	Wood
	Texture	Wood
	Pattern	None
Behavioral 40%	Functionality	Small volume
	Fun of use	None
Reflective 10%	Brand	None

Table 16 solution 2's design factors

Solution 3 :

Visceral 50%	Shape	Streamlined
	Color	Warm
	Material	Glass
	Texture	None
	Pattern	None
Behavioral 40%	Functionality	Small volume
	Fun of use	None
Reflective 10%	Brand	None

Table 17 solution 3's design factors

5.6.2 Visualization:

CAD models visualizes the different design ideas. User's emotion cards are used in this step to review emotion stimulus. Besides, reviewing user emotion cards and research information cloud also helps designers extract the key words of the design. From Lily's user emotion card and research data, the tableware should have vitality, be minimalistic, and suggest refraining from overeating but encouraging cooking. It should bring fun and decorate her room.

Plate design: There are six plate design ideas generated with streamlined side views and wavy forms. The selected bowl is marked with a circle.
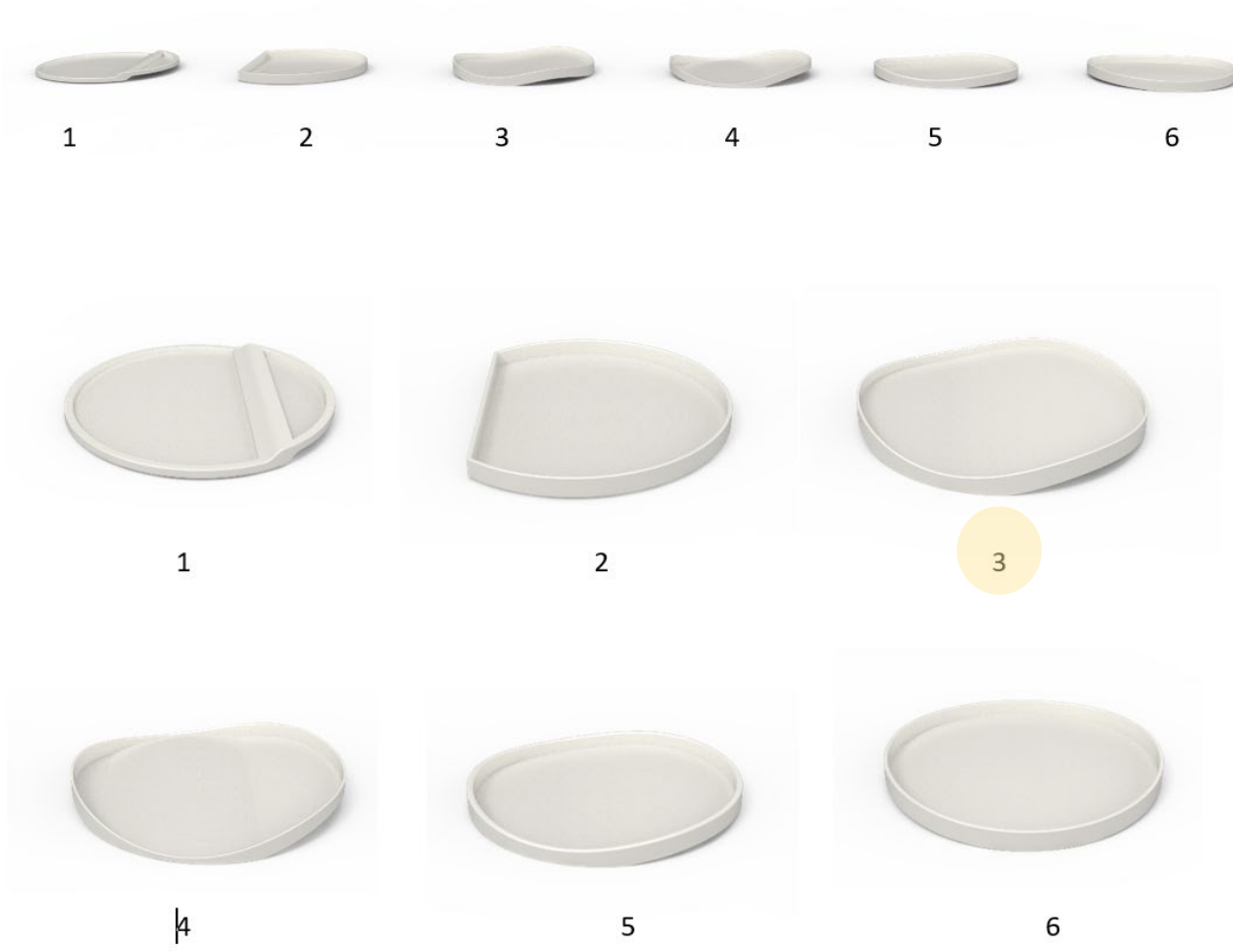
Figure 31 Plate design

Bowl design：There are seven bowl ideas with a sloped design to achieve a visual dynamic effect. The selected bowl is marked with a circle.
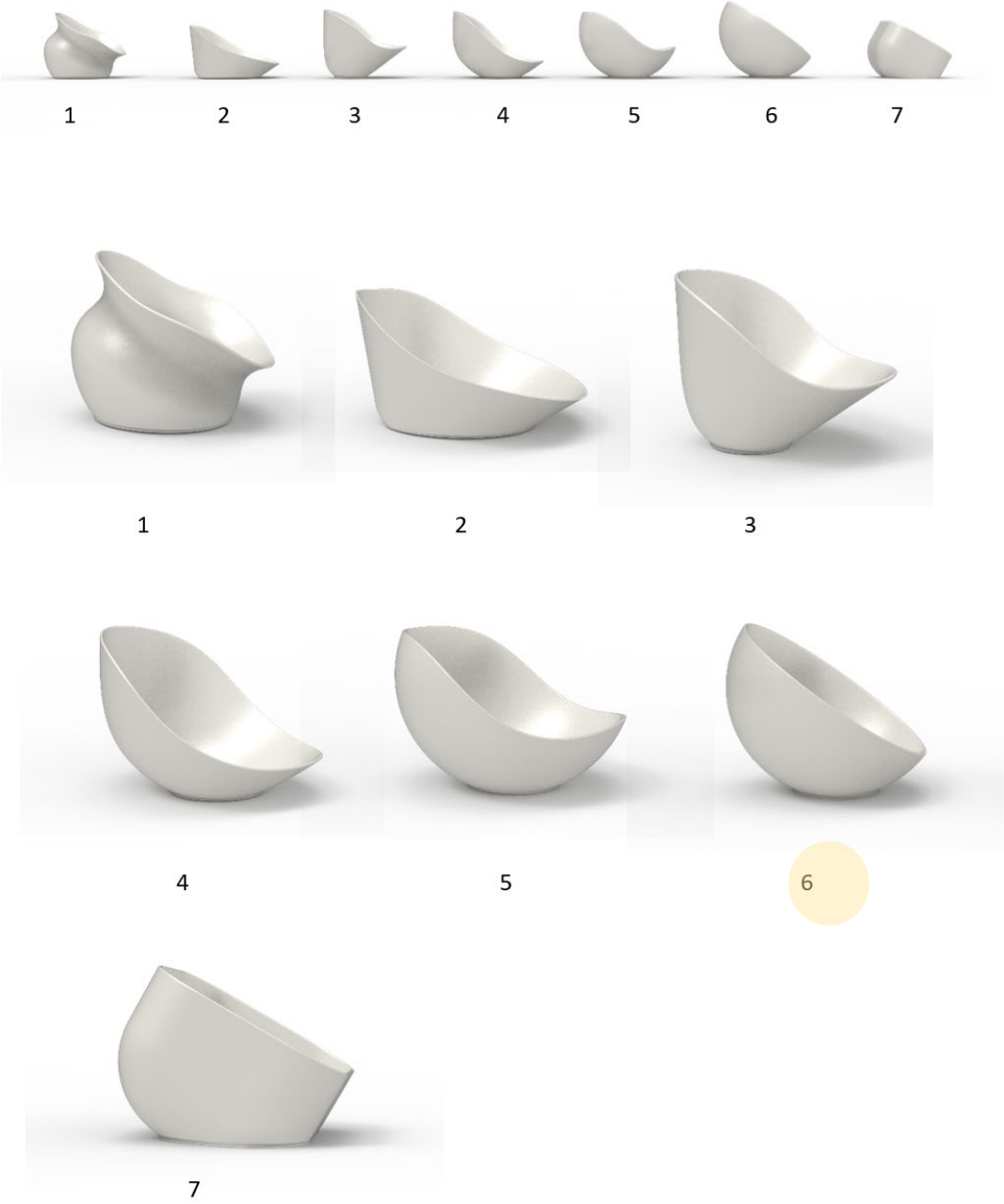

Figure 32 Bowl design

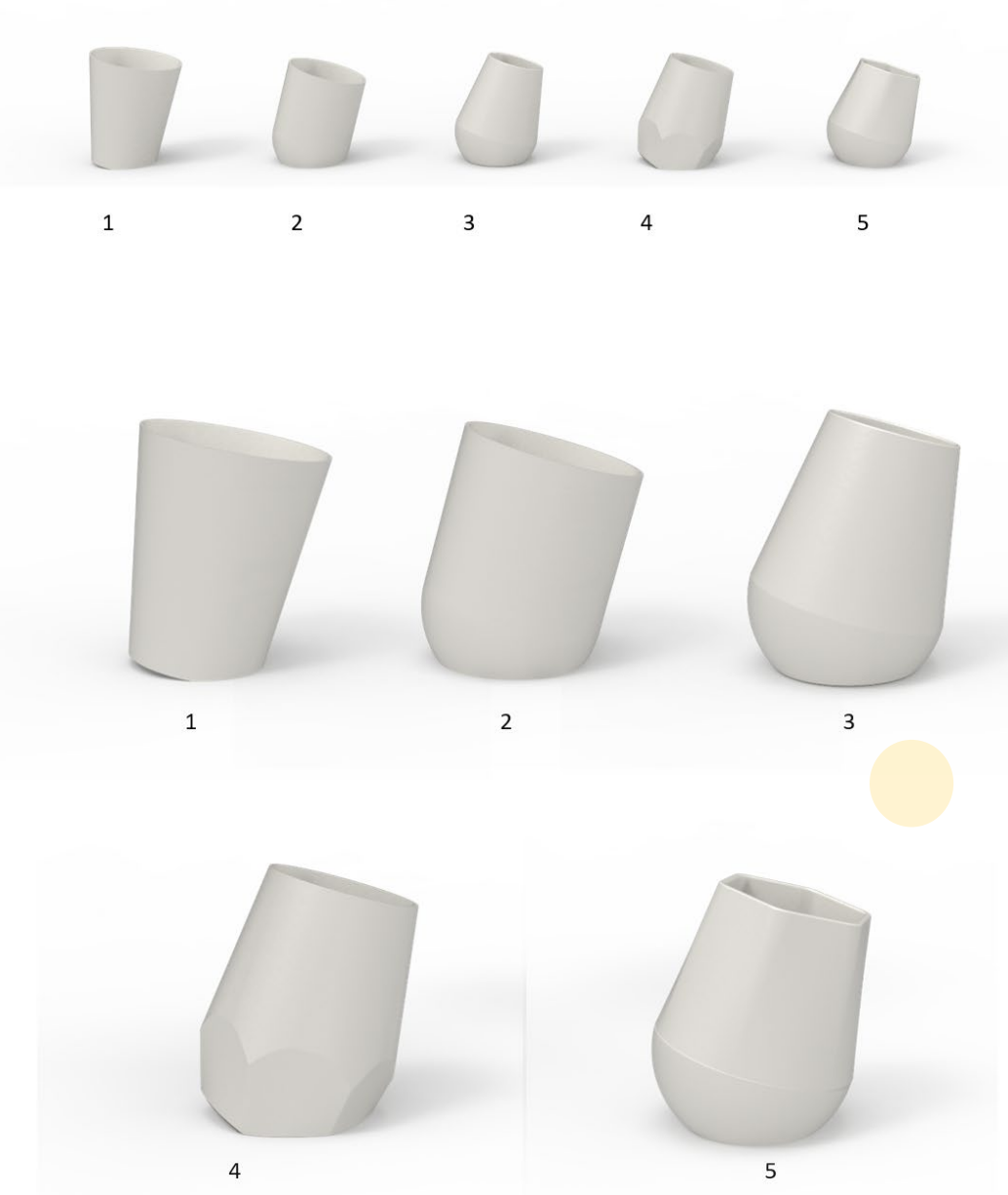Mug design: There are five corresponding mug design concepts. The selected bowl is marked with a circle.
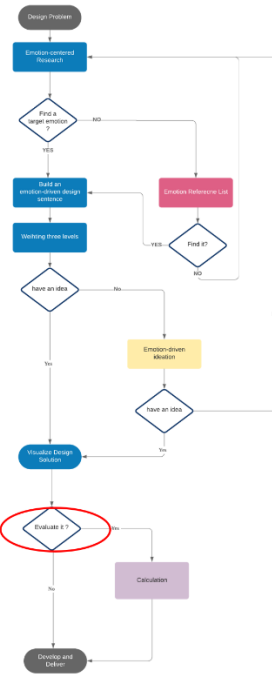

Figure 33 Mug design

5.7 Evaluation:

Evaluation

Purpose: Help evaluate a design solution.
It could be used for comparing, developing or analyzing design solutions.

Suggestions : Refer to the Emotion Source Table.

How: Calculation : grade design solution in the three levels.

Calculation

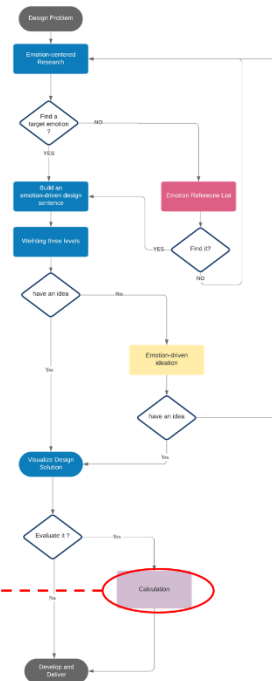**Purpose: Analyze an emotional design solution quantitively.**

How:

	Attitude	Goal	Standard
Visceral	Interest		
Behavioral			Satisfied
Reflective		Acceptance	

Sum = A % (Visceral score) + B% (Behavioral score) + C% (Reflective Score)

In the step 4, the product has been weighted in the three levels, each level should have a weighting value.

In the evaluation step, the final design solution will be grade at those three levels. For example, if the designer thinks the final design evoke "interest" partly, designer could grade it 40 % or 50 % accordingly, and times the weighting value.

A set of tableware contains a plate, a bowl, a mug , a spoon, and a pair of chopsticks designed for the target user to encourage her cooking and eating at home through evoking emotional needs. The streamlined side view and active form are inspired from user's emotional cards. The emotion cards decode user's attitude, goal and standard to assets of tableware. The form is more than attractive, and according to target user's need, the limited capacity is designed purposely to helps her control food portions.

Solution 1 :

Visceral 50%	Shape	Streamlined
	Color	Warm
	Material	Wood
	Texture	None
	Pattern	None
Behavioral 40%	Functionality	Small volume
	Fun of use	None
Reflective 10%	Brand	None

Table 15 solution 1's design factors

Figure 34 design solution 1

Solution 2 :

Visceral 50%	Shape	Streamlined
	Color	Sliver
	Material	Metal
	Texture	None
	Pattern	None
Behavioral 40%	Functionality	Small volume
	Fun of use	None
Reflective 10%	Brand	None

Table 16 solution 2's design factors

Figure 35 design solution 2

Solution 3:

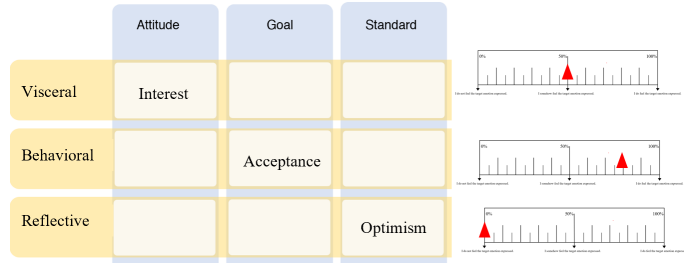| Visceral 50%	Shape	Streamlined
	Color	Warm
	Material	Glass
	Texture	None
	Pattern	None
Behavioral 40%	Functionality	Small volume
	Fun of use	None
Reflective 10%	Brand	None

Table 17 solution 3's design factors
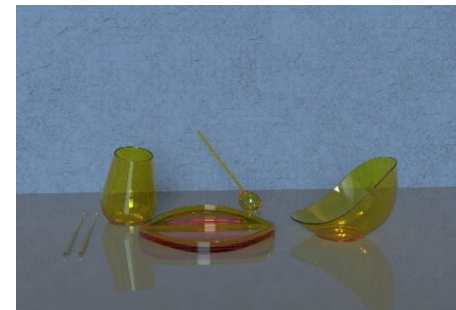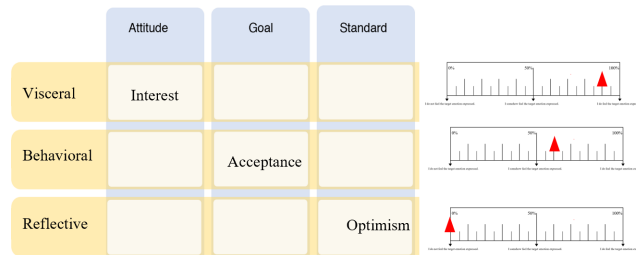

Figure 35 design solution 2

Solution 1' score : 50% x (50%) + 40% x (80%) +10% x (0%) = 57 %
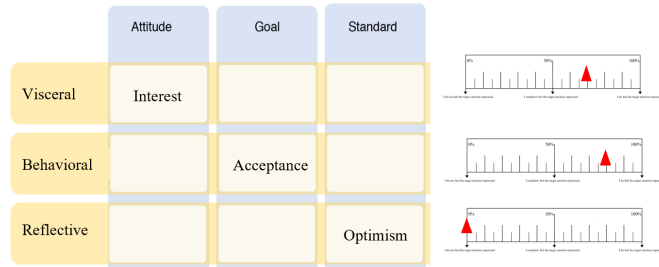
Solution 2's score: 50% x (70%)+ 40% x (80%)+ 10% x (0 %)= 67%
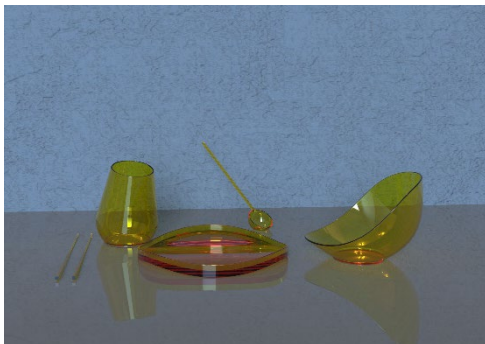
Solution 3's score : 50% x (90 %) + 40% x (60%) + 10% x 0= 69 %

According to the result, solution 3 has a highest score since it has a more attractive look. It has a lower score in behavioral level since it is easily broken; however, from target user's view, a tableware design's visceral level factors may be weighted more than behavioral. Solution 3's score

partly explains target user's consumption view. The evaluation part could be read from different aspects. The purpose of evaluation is for designers to self-examine selected design solutions.

In this chapter, a tableware design project demonstrates how to use the emotional design tools in chapter 3. This tableware design project shows how to find emotional trigger potential in early user research stage, and how to develop design solutions by using emotion cards and emotion-driven research. The evaluation stage introduces a method for designers to evaluate several design solutions and how to select a final solution from them.

Chapter 6

The emotional design stool introduced in chapter 4 is open-ended. Designer could adjust it accordingly as long as the design goals in each stages are achieved. There is another design project demonstrate how to use the design tool.
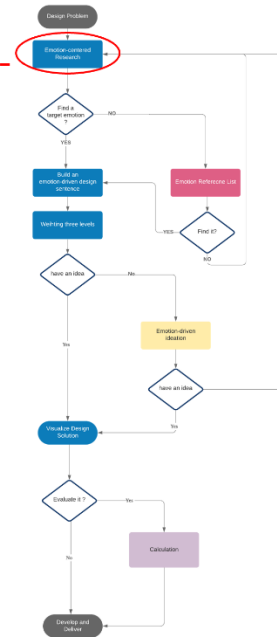
6.1 Emotion centered research

Emotion-centered Research

Purpose: Find user's emotional need.
Focus on user's attitude, goal and standard, knowledge and expectation.

Suggestion: PDD research + User Emotion Card

How: Immersing.
Storytelling.
Find User's emotion variety.
Collecting research information.
Make a set of user emotion card.

For designing a blender for target user Zhang, emotion centered research are done for collecting user's attitude, goal, standard, knowledge and expectation about blender.

Name: Zhang
Age: 22
Gander: Female
Family: living alone
Location: Shanghai China
Occupation: Student
Major: Media

Hobby
"I like yoga, dancing and cooking. I like healthy food and bodybuilding. Fruit and yogurt are the best."

Social Life
" I went to gym everyday and I live with my friends. we have pets."

Living Enviroment
"I have 2 roommates and we share kitchen and living room. We adopted two cats and a dog together "

Experience
"Recently, I find a part - time job and I becomes busy on weekdays. I need take subway to the workplace.

Figure 36   User research

Emotion: Happy

Stimuli: Eating fruit

Emotion: Eager

Stimuli: The new intelligent home system

Figure 37   Emotion card

From user emotional research, designer could list user's emotional need from attitude, standard and goal.

Attitude: cute

Standard: small size.

Goal: used at home and workplace.

6.2 Emotion screening

Target Emotion Screening

Purpose: Find the target trigger emotion.

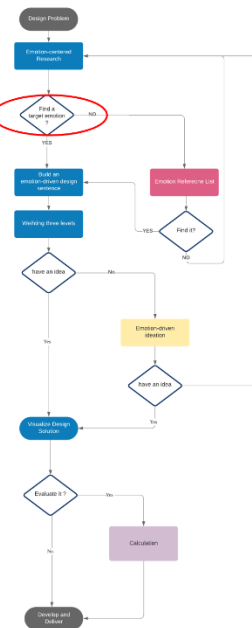**Suggestion**: Designer find the target emotion form Desmet's emotion source table or Plutchiks' Emotion wheel.

Product Emotion Source Table could be used for analyzing.

How : Analyzing user emotional research.

Find design potentials for triggering emotion.

Narrow down / expending target emotion to be triggered.

	Attitude	Goal	Standard
Visceral	Joyful		
Behavioral		Joyful	

6.3 Design sentence

Build a Design Sentence - - - - - - -

Purpose: Summary design goal from preceding emotional research and following design direction.

Suggestion: Design … for … to … through evoking …

How: Put design object, target user, design goal and target emotion into a sentence.
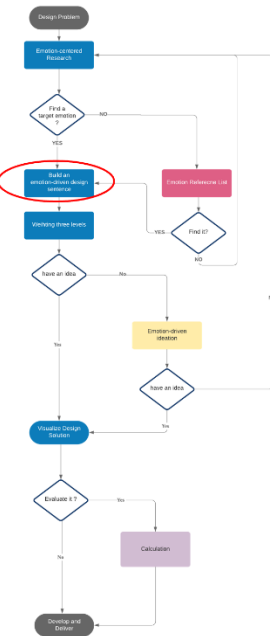
Design a blender for Zhang to encourage using through evoke

"Joyful" in the visceral level and

"Joyful" in the behavioral level.

"Acceptance" in the reflective level.

6.4 weighing

Weighting

Purpose: Analyzing possible design factors form three emotional design levels.

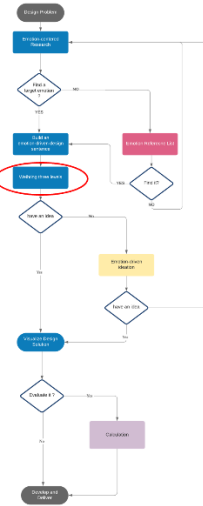Help designers guide design direction.

Works for final evaluation.

Approach: Weighting design product in a three emotional level's table.

How : Visceral level + Behavioral level + Reflective level = 100%.

Assign a value to each emotional level according to the product categories or design object.

Visceral level	A%
Behavioral level	B%
Reflective Level	C%

A % + B% +C% =100%

From designer's view, the behavioral and visceral are more decisive for user's emotion trigger. And behavioral level's emotional response are more important.

Visceral	40%
Behavioral	50 %
Reflective	10 %

Table 19 Weighting table

6.5 Ideation

Ideation

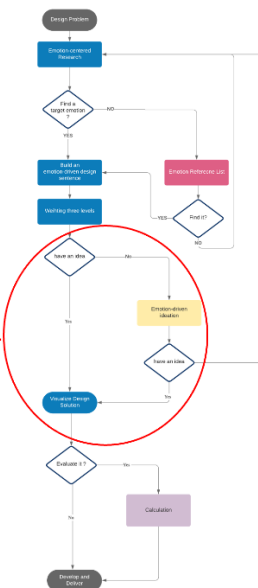**Purpose:** To visualize emotion-driven design solutions.

Suggestion: Fill in the design factors table.

How: 5.1 List design factors that may help evoke target emotion.

5.2 Research emotion driven design factors.

5.3 Update the list of design factors.

5.4 Visualize design solution through Sketch / CAD   Model / Physical Model.

Listing the possible design factors to trigger the target emotion " joy". After that, brainstorm or research about the relationship between design factors and the target emotion will be accomplished.

Visceral	40%	Shape
		Material
		Color
Behavioral	50 %	Functionali
		Fun of Use
Reflective	10 %	Brand

Table 20 Design factors table

Update design factors and Visualization :

Visceral	40%	Shape	Lime
		Material	Plastic
		Color	Lime green
Behavioral	50 %	Functionality	Ease use
		Fun of Use	Fun lid
Reflective	10 %	Brand	Brand

Visceral	40%	Shape	Avocado
		Material	Plastic
		Color	Green
Behavioral	50 %	Functionality	Ease use
		Fun of Use	Lighting
Reflective	10 %	Brand	Brand
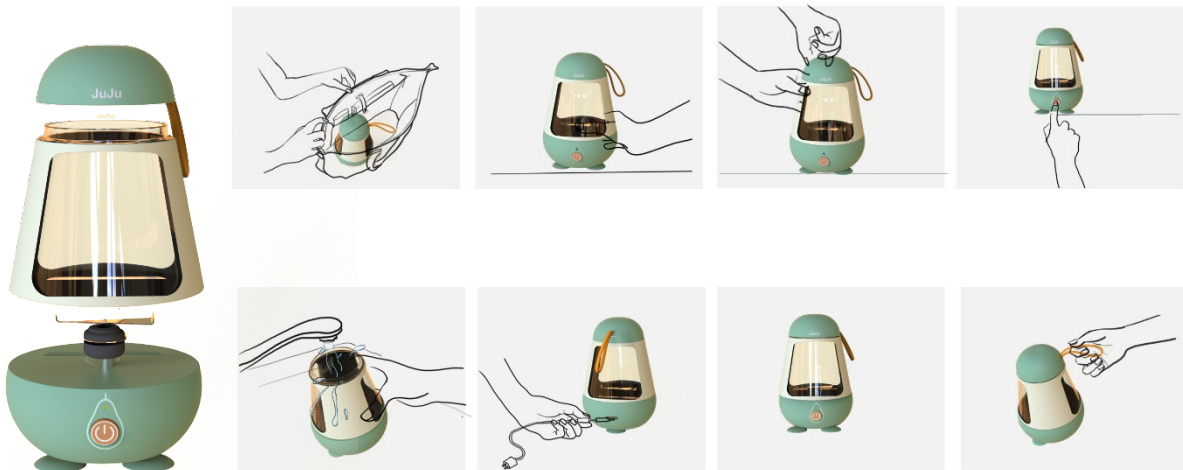
Figure 38 Design solution

6.6 Evaluation

Evaluation ---------------------------------

Purpose: Help evaluate a design solution.
It could be used for comparing, developing or analyzing design solutions.

Suggestions : Refer to the Emotion Source Table.

How: Calculation : grade design solution in the three levels.

Calculation ---------------------------------

Purpose: Analyze an emotional design solution quantitively.

How:

	Attitude	Goal	Standard
Visceral	Interest		
Behavioral			Satisfied
Reflective		Acceptance	

Sum = A % (Visceral score) + B% (Behavioral score) + C% (Reflective Score)

In the step 4, the product has been weighted in the three levels, each level should have a weighting value.
In the evaluation step, the final design solution will be grade at those three levels. For example, if the designer thinks the final design evoke "interest" partly, designer could grade it 40 % or 50 % accordingly, and times the weighting value.

The portable blender with an avocado form has a pattern around the button. The avocado pattern will be lighten up automatically once the power on button is pushed to indicate its working status. The color is selected for associating with avocado. This is inspired by user's emotion card, the fruit evoke user's happy. Also the small size and hand strap are designed for weaken the disappointed for the crowded public transport.

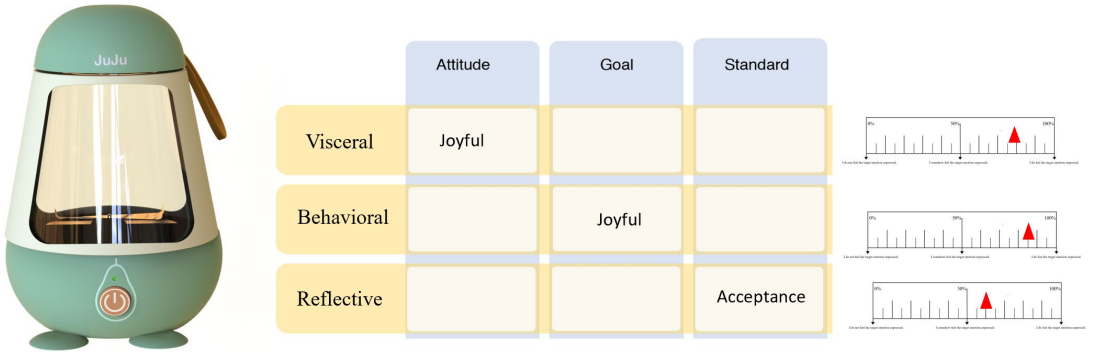|	Attitude	Goal	Standard
Visceral	Joyful		
Behavioral		Joyful	
Reflective			Acceptance
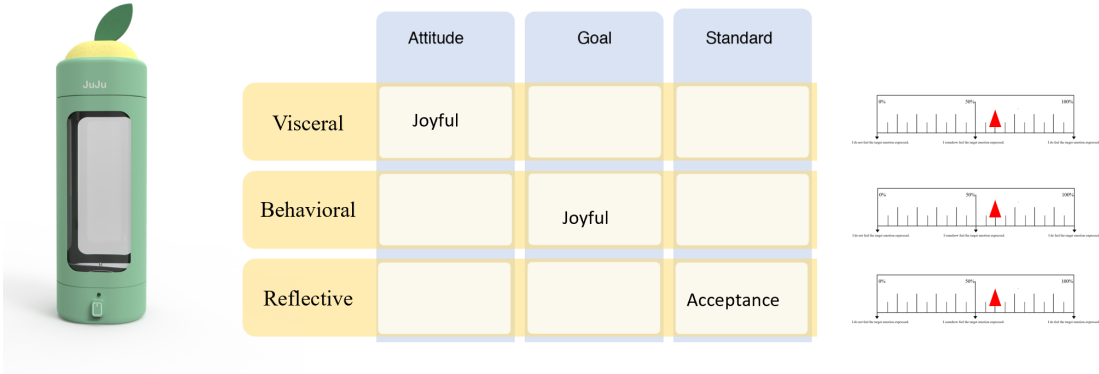
Score: 40 % x (60%) + 50 % x(60%) +10 % (60%) = 60%

	Attitude	Goal	Standard
Visceral	Joyful		
Behavioral		Joyful	
Reflective			Acceptance

Score: 40 % x (80%) + 50 % x(85%) +10 % (60%) = 80.5%

The avocado blender for target user evoke interest from the visceral and behavioral level through its form, color and fun of use. However, it scores low in the reflective level since the designer put less effort on branding design.

Chapter 7 Conclusion

This thesis provides an emotional product design tool for designers to solve design problem through evoking user emotion. Emotional theories in the literature review part also states that emotion factors in product design is an essential part to be focused on. Adding emotional design factors into products makes them be more impressive and competitive.

This thesis also provides a design tool in chapter 3 to help designers plan an emotion-driven design process containing emotional research in early stage to evaluation design solutions at the end. The diagrams and guidelines in this thesis provide references for designer to organize research information and apply this research information into ideation and evaluation. For emotion factor's extraction, this thesis provides a tool free method that helps designer make design decisions quickly in an early stage. A more accurate method for extracting user emotional needs is also accepted.

As technologies develop, emotional design will have more potential to be used in different design fields. Mapping user's emotional need to design product will be more efficient and accurate. Designers will have more opportunities to collect emotional data and improve design concepts.

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