

Design Guidelines for Product that Influence Consumers' Value Perception

by

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Abstract

When consumers meet a new product and make purchase choice, they will have a first impression. Most first impressions connect to the exterior performance of this product, which may include the form implication and visual function judgments. All of these will influence the consumers' value perception. The customers' value perception is an evaluation criteria that is related to the concept of perceived value or perceived quality (sometimes not the real value or quality) and consumers' background. This thesis focuses on finding all the possible factors that influence consumers' value perception, and how these factors have an impact on consumers' evaluations, especially when they make a purchase choice. Finally, this thesis will determine guidelines to direct product designers to create or improve their design by controlling the end users' value perception. By following the guidelines, which includes contextual difference, functions, form, and human factors, designers will design a product that meet the consumers' value perception, and will have a higher possibility to ensure the success of product design in the market, bringing higher profit to the manufacturer.

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Table of Contents

Abstract	ii
Acknowledgments.....	iii
List of Tables	v
List of Illustrations	vi
List of Abbreviations	vii
Chapter 1 Introduction	1
1.1 Problem Statement	1
1.2 Need for Study	3
1.3 Objectives of Study	4
1.4 Definition of Terms	5
1.5 Scope and Limits	7
1.6 Anticipated Outcome.....	8
Chapter 2 Literature Review	10
2.1 Background.....	10
2.2 Value Analysis and Value of Product.....	11
2.3 Consumer Perceived Value, Quality, and Price.....	14
2.4 Consumer Behavior: Decision Process	17
2.5 Consumer Behavior: Successful Products	21
2.6 Form Influence.....	23

2.6.1 The Appearance, Aesthetics, and Form of Product	24
2.6.2 Color	26
2.6.3 Lines and Shape.....	30
2.6.4 Texture.....	33
2.6.5 Material.....	35
2.6.6 The Principles of Design.....	39
2.7 The Function and QFD Method in Product Design.....	42
2.8 Human Factors	47
2.8.1 Physiological Characteristics of Humans	48
2.8.2 Psychological Characteristics of Humans.....	51
2.8.3 Product Safety.....	53
2.8.4 Human Factors Data Sources.....	55
2.9 The Contextual Difference	56
2.9.1 Culture in Contextual Difference.....	59
2.9.2 Subculture in Contextual Difference.....	61
2.10 Other Factors	64
2.11 Conclusion.....	66
Chapter 3 Guidelines.....	67
3.1 Design Guidelines Development.....	67
3.2 Relationship between All Factors and Design Process.....	78
3.3 Conclusion: Design Guidelines.....	80
Chapter 4 Design Application.....	80
4.1 Introduction	80

4.2.1 Contextual Difference Evaluation.....	81
4.2.2 Function Evaluation.....	82
4.2.3 Form Evaluation	84
4.2.4 Human Factors Evaluation.....	87
4.3 Redesign Application: The High Value Bluetooth Speaker	90
4.3.1 Concept Development: From Sketches to CAD	90
4.3.1.1 Contextual Difference: Target User Group.....	90
4.3.1.2 Function Redesign	94
4.3.1.3 Form Redesign	97
4.3.1.4 CAD and Conclusion	99
4.3.2 Concept Evaluation and Final Model: Human Factors	103
4.3.2.1 Human Factors: Evaluation Concept.....	103
4.3.2.2 Final Model.....	105
4.4 Conclusion.....	106
4.5 Recommendations and Further Study	107
References	108

List of Tables

Table 1	27
Table 2	28
Table 3	28
Table 4	29
Table 5	50
Table 6	62
Table 7	64
Table 8	68
Table 9	71
Table 10	75
Table 11	83
Table 12	95

List of Figures

Figure 1	16
Figure 2	18
Figure 3	19
Figure 4	21
Figure 5	31
Figure 6	32
Figure 7	34
Figure 8.....	40
Figure 9	41
Figure 10	46
Figure 11	50
Figure 12	52
Figure 13	58
Figure 14	60
Figure 15	65
Figure 16	69
Figure 17	72
Figure 18	76

Figure 19	79
Figure 20	82
Figure 21	84
Figure 22	85
Figure 23	86
Figure 24	87
Figure 25	88
Figure 26	93
Figure 27	94
Figure 28	96
Figure 29	97
Figure 30	98
Figure 31	99
Figure 32	100
Figure 33	102
Figure 34	102
Figure 35	104
Figure 36	104
Figure 36	106

List of Abbreviations

CAD Computer Aided Design

QFD Quality Function Deployment

CHAPTER 1

INTRODUCTION

1.1 Problem Statement

Most first impressions when consumers meet a new product will connect to the exterior performance of this product, which will influence the consumers' value perception. The customers' value perception is an evaluation criteria that is related to the concept of perceived value. This thesis will analyze factors that influence consumers' value perception, and how these factors have an impact on consumers' evaluations.

When studying how to influence consumers' value perception in product design, the first problem is how to find the factors that influence value perception. Although the real value will affect the evaluation of the product, the perceived value is not equal to the real value. The consumers' value perception judgment may be affected by form aesthetics, quality, functions, services, and consumer contextual difference. Finding all the factors and analyzing how each one influences the value perception will be a significant challenge.

The second challenge will be how to classify the factors that influence value perception. The working assumptions of the guideline categories include form, function, human factor, and contextual difference. The study of functions may consist of human function, production function, and technical function. However, human function is related to the study of human factors. In addition, human function is affected by contextual difference, because the consumer groups may be from different cultures, countries, races, ages, genders, etc. In other words, even if the categories in the guideline

can be determined, some of the factors interact with each other. To find the relationship among them will be another important part of the formation of the guidelines.

The third problem is how to research and summarize the contextual difference, which comes from different end user groups various perceptions towards certain products. There are so many contextual factors that can influence consumers' value judgments, and finally affect their perceptions about the value or quality. These qualities include consumer's culture, country, race, age, gender, and so on. Plus, in different purchase environments, people may make totally different decisions, because consumers are easily affected by surroundings. To analyze the contextual difference requires careful attention in the literature review.

Besides considering the factors that may influence the consumers' value perception, there indeed are some existing factors that cannot be determined by designers, such as the time, brand, permanent value, product services, selling environments, etc. Though different times or the brand will influence the judgment about product value, there are still some common classic product characteristics that can be concluded to be the primary evaluation principle. Due to the fact that there are some properties of the product that cannot be only determined by designers, such as brand, times, services, and so on, how to use the guidelines to improve the universal properties of products that can be decided by designers will be the most important target of this study.

In order to determine the items to include in the proposed guidelines, a survey is conducted. To analyze the data from the survey, considering some available design theories may be helpful for the result, such as consumer behavior, consumer psychology, the study of form and appearance, visual function analyze, human factor, consumer

cognition study, semantics, anthropometry, etc. All of these will be references for the study to determine proper criteria of value perception.

1.2 Need for Study

“Product design is an opportunity for differential advantage in the marketplace” (Creusen & Schoormans, 2005, p. 64). With the advent of globalization, informatization and a post-industrial society, researchers have begun to pay more attention to the relationship and further influence between consumer and product, consumer and designer. “User-centered design (UCD) is a methodology used by developers and designers to ensure they’re creating products that meet users’ needs” (Lowdermilk, 2013, p. 13). The guidelines developed in this study, which focus on consumers’ value perception, are used for directing product designers or even product researchers. Through analyzing the factors that influence consumers’ value perception, this study will develop a systematic model to tell designers what kind of products can make the target consumers have a high or ordinary or even low perceived value feeling towards a particular product. In other words, the guidelines connect consumers and designers, and enhance the interaction between consumers and products.

There is much research of value, and some research about perceived value, quality, and price, as well as of the relationship between consumer and product. “The value concept from a value-to-customer perspective exists only to a limited extent in the marketing literature” (Grönroos, 1997, p. 412). This study is based on previous theories to develop a systematic and detailed set of guidelines, and the guidelines are built from the role of product designers to further direct designers. The guidelines focus on the

study of value perception, to try to find the factors that influence consumers' evaluation.

In addition, this guideline may be insufficient in concluding all the factors that influence value perception, but it will contain mainly the necessary aspects, and the most significant one is to find "how to influence" instead of only to list the factors. This part is also a supplement to available literature, and the guidelines will indicate a good direction for the study of the relation between consumer, designer, product, and market.

Furthermore, due to the concept that perceived value, quality, and price are not equal to the real ones, trying to find the connection between them will help designers realize the real significance in the design and bring a higher possibility to create a successful product that meets the needs of the market. Moreover, this result will also bring higher profits to the company and manufacturers.

1.3 Objectives of Study

- To study value and value perception
- To define perceived value, quality, and price in the context of this study
- To find current aspects that influence or control consumers' value perception when they decide to purchase a certain product
- To analyze the consumers' psychological needs when they choose the product they want
- To study the interaction between users and products from the point of value perception and how this evaluation affects consumers' behavior
- To classify the available factors and form the main categories of the guidelines
- To research the consumers' needs in product design from product form aspect and

how to use form design to find the consumers' needs about particular products

- To research the influence of product function, and the relation between the function value and form value
- To research the human factors that include the study of ergonomics, anthropometry, cognition and semantics
- To research contextual difference, and find how to influence value perception through contextual difference
- To find other factors that may influence the value perception and that can be controlled by producers, sellers, service suppliers, etc.
- To develop product design guidelines that influence consumers' value perception
- To evaluate a certain product by using the prototype of guidelines
- To demonstrate the guidelines through a product redesign project

1.4 Definition of Terms

Anthropometry: “The study of human body measurements, especially on a comparative basis” (“Anthropometry”, n.d.).

Cognition: “Conscious mental activities: the activities of thinking, understanding, learning, and remembering” (“Cognition”, n.d.).

Compatibility: “It refers to the degree to which the product is consistent with existing values and past experiences of the potential adopters” (Engel, Blackwell, & Miniard, 1990, p. 692).

Complexity: “It’s the degree to which an innovation is perceived as difficult to understand and use” (Engel, Blackwell, & Miniard, 1990, p. 693).

Ergonomics: “An applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely —called also biotechnology, human engineering, human factors” (“Ergonomics”, n.d.). Thus, ergonomics can be equal to human factors.

Five-stage Consumer Decision Process: “These five stages, Problem/Need Recognition, Information Search, Alternative Evaluation, Purchase, and Post-Purchase/Outcomes, were first introduced by John Dewey in the early last century” (Lee, 2005, p. 7)

Observability: “Observability and communicability reflect the degree to which results from using a new product are visible to friends and neighbors.” (Engel, Blackwell, & Miniard, 1990, p. 694).

Perceived Quality: “Perceived quality can be defined as the consumer’s judgment about a product’s overall excellence or superiority” (Zeithaml, 1988, p. 3)

Relative Advantage: “To what degree the new product will be a substitute for existing ones or complementary with the array of products already in consumers’ inventories”

(Engel, Blackwell, & Miniard, 1990, p. 692).

Semantics: “the study of the meanings of words and phrases in language, the meanings of words and phrases in a particular context” (“Semantics”, n.d.).

Trialability: “New products are more apt to succeed when consumers can try or experiment with the idea on a limited basis” (Engel, Blackwell, & Miniard, 1990, p. 693).

1.5 Scope and Limits

Scope

- The result of this study will be suitable for the majority of products, and for most product designers.
- This study is directly related to consumer behavior and psychology.
- The final theory of this study will direct all product designers through analyzing all the possible factors that may influence the consumers’ value perception.
- The range of research will include form study, function study, human factor, and contextual difference.

Limits

- It is hard to test the factors’ degree of influence on consumers’ value perception.
- Mainly focusing on the most commonly used products, the result of this study cannot cover all categories of products.
- Because the value perception can be totally different for different people, this study can only draw a theory that has a valuable reference for most consumer groups.

- Due to some factors that are hardly controlled by product designers, such as time, brand, the inherent value, services, selling environment, etc., these factors will not be included in the guidelines.

1.6 Anticipated Outcome

The design guidelines to influence consumers' value perception should become a wide ranging tool that are suitable for the majority of products, and should guide designers to deeply understand the real interaction between the product and consumers as well.

Here are some possible findings. First, the results will improve the communication between products and consumer groups so that designers can effectively create a more useful and popular product for the target users. Second, this research will help designers to figure out the relationship between products and consumer cognition, design and user psychology, design and market. Third, it will direct designers to find more efficient methods to create valuable manufactured products in the future.

The deliverables of this study will be a systematic theory to figure out the interaction between consumers and products from a value perspective, and direct designers to control the influence of products' outward manifestation for the end users. Using this guideline, designers can decide how to create a product that the market really needs. In addition, the designers can control the evaluation of consumers. For instance, the product can be designed to appear as a more highly valuable one with a lower cost. Therefore, the truly tangible results generated from the study can boost the sales of one product and bring higher profits.

Finally, this research will benefit not only the company or individual designer, but also the revolution of product design and the improvement of society.

CHAPTER 2

LITERATURE REVIEW

2.1 Background

“The concept of design quality can be defined as a value judgment as a result of the interaction between a product and an individual in the context of a value system of the group” (Volker, 2010, p. 36). The evaluation of a product, in many cases, depends on the users’ value perception. When people meet a new product, they will have a first impression. Most of the time, this first impression connects to the exterior styling of the product because it can bring some kind of form implication to the consumer. When the end user touches or uses the product, the functions and interaction factors will further affect the end user’s evaluation. “Research has shown that people tend to imagine products as having personalities and that they tend to express a preference for products that they perceive as reflecting their own personalities” (Silva & Simoes, 2011, p. 224). In product design area, the product properties, such as form, function, and human factor, will influence the consumers’ value perception. In addition, in the consumer aspect, the context will greatly affect the value judgment for individual groups as well because the perception of products is reflected from the personalities of consumers themselves.

Thus, the study of the factors that influence consumers’ value perception is the research of interaction between consumer and product. For instance, that the end user perceives one product has a high quality means he or she can accept this product. That the product can be accepted by the target consumer shows that people are willing to pay for it, if we do not consider the consumers’ financial capacity. If this product is so attractive that the majority of consumers want to own it, sales will greatly increase. For

most product designers, the impressive sales of the product mean that this product will generate more profits for the company. “The primary objective of any manufacturing organization is to create profit” (Ward & Augus, 1996, p. 23). Therefore, consumers’ perception of value will affect the profit of a company, and that is why the product designer needs to find a method to affect or even control the consumer’s choice of one product. In other words, designers should understand what consumers really want to pay for, and what kind of product can be considered a valuable commodity.

This study is going to determine the factors that influence consumers’ value perception to form design guidelines, and discuss how these factors affect the end users’ purchase choices through analysis of existing research.

2.2 The Value Analysis and Value of Product

In product design area, there is limited published literature focusing on the study of value analysis (VA) or value engineering (VE). In the area of VA, some books can be referenced for the study of value perception in product design. Fowler (1990) in his book *Value Analysis in Design* defines and analyzes value and the application of Value Analysis. His research will be a basic theoretical support for value study in these guidelines.

According to Fowler (1990), the origin of value analysis is from the late 1940s at the General Electric Company, and “it’s a system for harnessing people first to identify problems and then to select and apply the appropriate problem-solving procedures” (p. 1). The corporate leaders began to become aware of the importance of controlling value in their “purchasing-based” and “management-based” system for maximizing benefits

of their products and projects. After that, the value analysis system was set up in many companies and accepted by other countries. “Value analysis is presently used by about 10,000 organizations” (Fowler, 1990, p. 13).

The Value Analysis is a system used for solving problems, and the Value of Product is only one branch of this system. “Value analysis, therefore, is the umbrella system that makes optimal use of the nearly infinite number of formalized, focused problem-solving systems, including total quality control, quality function deployment, industrial engineering, industrial design, purchasing analysis, design for manufacturability” (Fowler, 1990, p. 14)...

What is value? According to Fowler (1990), the equation for modern value analysis includes the definition:

$$\text{Value} = \frac{\text{user's initial impression} + \text{satisfaction in use}}{\text{first cost} + \text{following costs}}$$

Cost is not simply the initial price, but must also include follow-on costs during the life cycle of the product (p. 19). From this definition, the impression and satisfaction are subjective factors, and the following costs are also difficult to measure. The relationships between perceived value and the real value, the quality and value, the worth and value are difficult to study separately.

“The original objective of value analysis was to reduce the cost of existing products” (Fowler, 1990, p. 23). Fowler pays more attention to the research of applying the value analysis into the problem-solving system of modern industry. Increasing worth and reducing costs will be a principle of development of the company that uses this system. However, this theory is more suitable for a team or a company that includes not

only designers to handle the whole process of product development. It points out the direction of “how to do” for a group, such as how to do the interviews, questionnaire, voting, and competitive evaluation, but it does not describe in sufficient detail for directing product designers how to improve their design in relation to value.

Based on the research of original value, there are several works to further study the evaluation of product value. According to these works, the “value” includes two implications. The first one is what is usually meant by “cost of product”. Defined by Neap and Celik (1999):

The value of a product includes cost and a subjective part associated with cost.

This subjective part of value reflects the owner(s)/buyer(s)’ desire to obtain or retain the item or how much the owner(s)/buyer(s) are prepared to pay for prestige, appearance, aesthetic, judicial, religious or moral reasons, or any combination of these reasons (p. 184).

The cost and subjective part associated with cost influence the price of a product to some extent. Compared with a similar product that has the same functions, higher value may be a contributing factor to make a higher priced product.

The second implication is considered from the consumer aspect, which relates to consumers’ subjective judgment. It is difficult to exactly define the meaning of value. “Quality and value are indistinct and elusive constructs that often are mistaken for imprecise adjectives like ‘goodness, or luxury, or shininess, or weight’ ” (Zeithaml, 1988, p. 2). Consumers often define their perceived value with all these imprecise adjectives, because the value of consumer aspect is generally considered subjective criteria, and it varies with different individuals. “Value is a relation, not an objective” (Hall, 2014, p.

10). It is the consumer or consumer's choice that adds greater value to the product. In other words, the value of product should reflect what consumers really need. Mentioned by Zeithaml (1988), there are four consumer definitions of value: "(1) value is low price, (2) value is whatever I want in a product, (3) value is the quality I get for the price I pay, and (4) value is what I get for what I give" (p. 13). All these are psychological needs, therefore, the valuable product for consumers is the one that meets their psychological demands.

To conclude, the definition of "value" in this study will include the objective value and subjective value. The objective value is "the cost of product", and the subjective value is "a relationship between consumers and products". The latter one will get close to the study of value perception.

2.3 Consumer Perceived Value, Quality, and Price

"A customer's perceived value represents an overall mental evaluation of a particular good or service" (Beneke, Flynn, Greig, & Mukaiwa, 2013, p. 219). In many cases, the consumer perceived value is different than the real value. As the discussion mentioned above, the value is usually defined by the "cost of product" which is directly related to the price of the product. What will influence the real value of the product? Zeithaml (1988) mentioned, "quality is a relatively global value judgment" (p. 5). Indeed, how to improve the quality of product is the primary task. However, the quality is usually limited by manufacturing factors that are related to the production cost. For most products, using alloy rather than ABS will increase production cost. For example, the alloy shell speaker generally has higher value than the ABS shell one. For product

designers, the cost of the product cannot be only controlled by themselves. Instead, they can control the perceived value of product design. In other words, using an appropriate design approach to increase the consumers' perceived value will be more effective for product designers because these elements are more under designers' control.

“There is a positive relationship between the perceived quality and perceived value of a product” (Beneke, Flynn, Greig, & Mukaiwa, 2013, p. 220). In this study, consumers' judgment is based on the first impression when they first meet a new product. Thus, the perceived quality will be first influenced by the appearance of the product. Consumers will have a first quality evaluation, and whether it is evaluated as high or low will lead to a corresponding value judgment. “A higher perceived product quality may increase the perceived value and, consequently, a customer's willingness-to-buy” (Beneke, Flynn, Greig, & Mukaiwa, 2013, p. 220). The quality and value perception of a first impression can be controlled by the form of the product to a large extent.

Higher value and quality often means a higher price at which the product can be sold. That is determined by consumers' willingness of how much they want to pay for the product, because they believe the product has equal value with the price. “Accordingly, it has been found that a significant negative relationship exists between perceived price and perceived value in that a high price erodes purchasing power” (Beneke, Flynn, Greig, & Mukaiwa, 2013, p. 219). In consumer psychology, the higher price will make an impression that this product is more valuable for some of the consumers. Thus, for some extent, raising price properly will add perceived value.

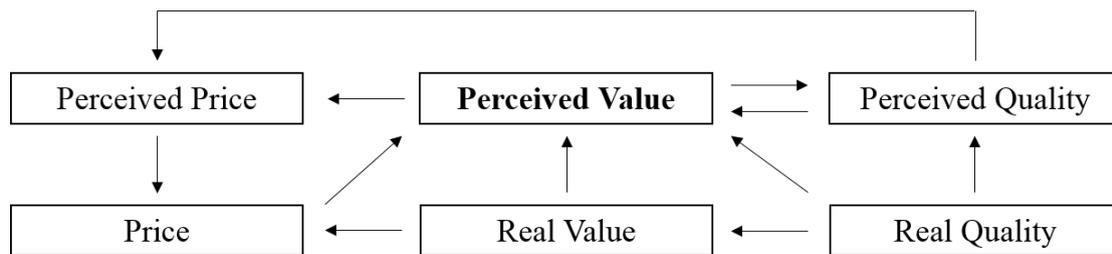


Figure 1. Relationship of Perceived Value, Quality, and Price

“Consumer perceptions of price, quality, and value are considered pivotal determinants of shopping behavior and product choice” (Zeithaml, 1988, p. 2). To draw conclusion for the guidelines factors that influence value perception, the first mission is a clear awareness of the relationship between value perception, quality perception, and price perception. In Figure 1, the arrow direction shows the relation of influence. For example, the Perceived Value is influenced by Perceived Quality, Real Quality, Real Value, and Price. At the same time, Perceived Value influences the Perceived Quality and Perceived Price as well. In general, the final target of controlling the perceived value is to be knowledgeable about the market value, thereby further controlling the psychological expectation price of consumers.

Zeithaml (1988) determines the definition and relationship among perception of value, quality, and price. “Reducing monetary and nonmonetary costs, decreasing perceptions of sacrifice, adding salient intrinsic attributes, evoking perceptions of relevant high level abstractions, and using extrinsic cues to signal value are all possible strategies that companies can use to affect value perceptions” (Zeithaml, 1988, p. 18). Based on these five theoretical and macroscopical strategies, which will be discussed in the following sections, this thesis will conclude specific guidelines for directing the product designers to control perceived value.

Through analyzing the relationship among the factors introduced here, it is

obvious that some factors that influence the value perception cannot be controlled by designers, such as the setting of retail price, the manufacturing cost, the processing quality, etc. Thus, to distinguish the necessary and useful factors for designers is very significant for the conclusion of the guideline. That is, what factors can be determined by designers and what factors changed by designers will control the consumers' value perception.

2.4 Consumer Behavior: Decision Process

Consumer behavior is defined as “those actions directly involved in obtaining, consuming, and disposing of products and services, including the decision processes that precede and follow these actions” (Engel, Blackwell, & Miniard, 1990, p. 3). Analyzing consumer behavior is actually analyzing the consumer and helping designers to understand consumers. The decision process will be a basic tool to figure out consumer perception.

The most pertinent consumer perception study is from the literature on consumer behavior. “Perception is the process of organizing, interpreting, and deriving meaning from stimuli through the senses: seeing, hearing, touching, tasting, and smelling” (Monroe, 1977, p. 289). Perception is related to the cognition of objects, so it is a result, for consumers, after communication with product. A perception study needs to be based on the study of consumer behavior and psychology.

“The buyer is subject to many influences which trace a complex course through his psyche and lead eventually to overt purchasing responses” (Kotler, 1965, p. 37). Kotler concludes a conception of buying process, as shown in Figure 2.

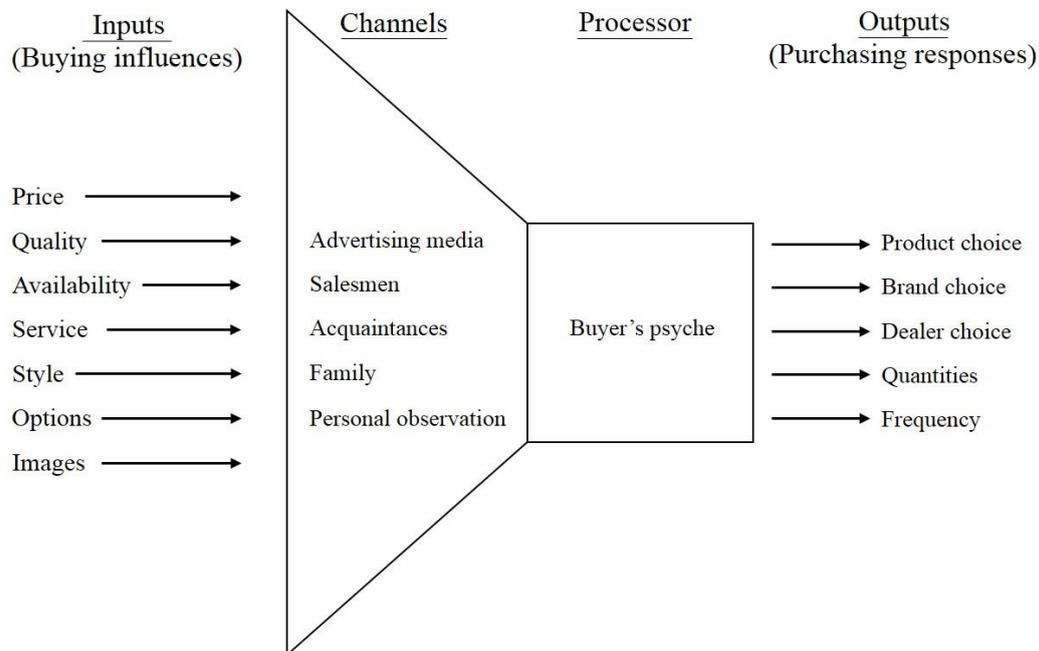


Figure 2. The Buying Process Conceived As a System of Inputs and Outputs

(Kotler, 1965, p. 38).

Figure 2 illustrates the complexity of figuring out how consumers make purchase choices. “Many factors can shape the final outcome, including internal motivations and such external influences as social pressures and marketing activities” (Engel, Blackwell, & Miniard, 1990, p. 26). Understanding the buying process integrates multidisciplinary knowledge, which includes marketing, brand analysis, psychology, etc. It is unnecessary to study all these areas; the conclusion of guideline needs to find references from the consumer decision process. “The study of consumer decision processes has been a focal interest in consumer behavior for over 30 years” (Bettman, Luce, & Payne, 1998, p. 187). Obviously, the study of consumers’ selection behavior and their thought processes will help designers to figure out consumers’ buying tendencies. Another five-step decision making mentioned by Engel, Blackwell, and Miniard (1990) is shown in Figure 3.



Figure 3. A Problem-Solving Perspective on the Five Steps in Consumer Decision Making (Engel, Blackwell, and Miniard, 1990, p. 28).

“These five stages, Problem/Need Recognition, Information Search, Alternative Evaluation, Purchase, and Post-Purchase/Outcomes, were first introduced by John Dewey in the early last century” (Lee, 2005, p. 7). Analyzing the typical consumer purchase decision process will illustrate a significant factor, which is contextual difference, that influences value perception. In other words, the research of the perceptual process is influenced by the consumer difference in context. In consumer behavior studies, the consumer is often categorized by group differences, such as age, gender, race, culture, experience, and so on.

Moreover, the shopping environment, the brand, and different times will influence consumers’ judgment as well. “The designers and consumers of a given product are often (but not always) separated by time, place or social group” (Crilly, Moultrie, & Clarkson, p. 554). Actually, there is not a particular and a universal methodology in consumer behavior and psychology studies to demonstrate what specific kind of product can be accepted by most consumers. The majority of available studies

need to conclude different approaches for different target users or other variables mentioned above.

“In many cases, however, values are universal. Who does not desire health, wisdom, or world peace?” (Solomon, 1999, p. 118). If focusing on the value research is related to consumer perception, which is based on the consumer behavior study, there can be a universal value principle that is suitable for most consumers and products, and usable for product designers. One example is “the ‘bug’, the small round shouldered car that became a generational icon in the U. S. in the 1960s and ’70s” (Stratton & Trinder, 1999, p. 94). The Volkswagen Beetle was designed in 1930s, with the new version still manufactured today (Figure 4). “By 1955, Volkswagen was selling more vehicles abroad (177,657) than at home (150,397), with the United States as VW’s most important market” (Rieger, 2010, P. 94). “The German ‘people’s car’ lived on in Brazil in 1985” (Baker, 2007, p. 111). “The old Volkswagen beetle was produced and sold in Mexico until 2003” (Grünig & Morschett, 2011, p. 284). Why do so many consumers from different cultures and different times accept the Beetle as their daily use vehicle? “The car’s distinctive shape and diminutive size gave it a cute and unthreatening aura” (Rieger, 2010, p. 114).



Figure 4. 1967: Performance Image/Alamy; 2014: Volkswagen of America

(O'Connor, 2013)

In the development of the VW Beetle, this car keeps the unique design of appearance, but still remains popular in the global market from 1930s until today. Just as Rieger (2010) said, a series of semantic metamorphoses have made this car so popular (p. 114). As this car demonstrates, there are still some universal design criteria in product design that can be accepted by most consumers without the influence of times and culture. This criteria will add value for consumer's judgment and influence the consumer's value perception.

2.5 Consumer Behavior: Successful Products

Another important aspect in consumer behavior is researching the properties of successful products. Mentioned by Engel, Blackwell & Miniard (1990), "The five

characteristics that are associated with success with new products include relative advantage, compatibility, complexity, trialability, and observability” (p. 691). This theory is summarized by marketing research, and it is a basic macro theory for finding the properties that add or reduce value to the product.

Relative Advantage is the consumers’ perception, whether the product is better than the existing ones or a complementary for the available ones. “New products most likely to succeed are those that appeal to strongly felt needs” (Engel, Blackwell, & Miniard, 1990, p. 692).

Compatibility means the new product should consist with consumers’ existing value systems. People have some inherent or permanent values that should be considered in the design of new product. For example, the red color in traffic products is usually considered to mean danger or attention. Most people believe that the golden watch is more expensive than a similar metal one, even if it actually may be only plated with gold.

Complexity means the product should be simple to understand and easy to use for consumers. “The more complex, the less likely the product is to succeed” (Engel, Blackwell & Miniard, 1990, p. 693). A friendly interaction, which means simple and clear operation with products, will be easily accepted by consumers.

Trialability for successful products means the company or retailer can provide some samples of products or the opportunity of trying a product before consumers purchase them. It is much applied to selling method.

Observability is visible use of a new product. If a good used product is operated by friends or neighbors, it will be easier to be accepted by consumers, because the seeing process will give the consumer motivation to purchase the same product.

Applying this marketing theory into the product design area will conclude the macro guideline for designers. On the one side, the product should meet consumers' needs, expectations, and existing value evaluation system. On the other side, the product should be designed to be simple to understand and easy to operate.

2.6 The Form Influence

“One of the most important deciding factors for selecting a product, especially for consumer products, is the aesthetics of the product” (Niku, 2009, p. 305). What the new product looks like will directly influence the first impression of consumers, and further influence their purchase decision. Although making products look better is not the only job for product designers, it is still the basic entry level that every designer should achieve. “The most important value to consumers in purchasing a specific kind of product should be the starting point in the design of the product appearance” (Creusen & Schoormans, 2005, p. 77). The attractiveness of the product is a valuable factor in consumers' decision. From the opinion of Dibb, Simkin, Pride, and Ferrell (2005), product quality, product design and features, and product support services are three aspects that add value to a product, and the physical appearance of the product in product design is one important fact of them (p. 329). Thus, in value perception study, the visual appearance will hold an important role. In analyzing the “look better” problem, most literature begins with the study of appearance, aesthetics, or form of products. For product designers, to figure out the difference and relation of these three terms and their influence on consumers' value perception is essential.

2.6.1 The Appearance, Aesthetics, and Form of Product

The term “appearance” is usually alternated with visual appearance in discussing the attractiveness of the product. Creusen and Schoormans (2005) define the “appearance of product” as “what consumers see of the product, the exterior” (p. 64). The “appearance” or “visual appearance” is not a specific term in product design; it usually means “the fact that something or someone arrives or begins to be seen” (Appearance, n.d.). Of all the definitions above, it is easy to conclude that the appearance (visual appearance) of the product is made of the objective exterior properties of products that can be seen by consumers. “A product’s appearance can have aesthetic and symbolic value for consumers, can communicate functional characteristics and give a quality impression (functional value), and can communicate ease of use (ergonomic value)” (Creusen & Schoormans, 2005, p. 63). A pleasing appearance will be attractive for consumers, and further add value to the product.

The term aesthetics is more specific than appearance in the product design area. “Aesthetics of a product or system relate to the way the product or system looks, its colors, shape, lines, textures, proportions of different elements, how the elements relate to each other, and the way they develop a perception about the qualities of the product” (Niku, 2009, p. 305). From this definition, aesthetics include objective parts and subjective parts. The objective parts mean the properties of products, from the exterior, and the subjective parts means the consumers’ perception about these properties, which is very close to consumers’ satisfaction, emotion, or pleasure. Thus, compared to the appearance, aesthetics are more related to the evaluation from the consumers’ aspect, which is associated with value perception.

The form of the product is very close to the definition of a system. “A system can be broadly defined as a set of elements and the relationships between those elements and their properties” (Lewalski, 1988, p. 145). That is an abstract term that includes the comprehension of objectivity and subjectivity. Mentioned by Niku (2009), “the form of a product has been likened to the interface between the inputs and outputs of two systems, one technical, another biological” (p. 308). The accuracy and full-scale definition of form is complex to understand. Viewed from the point of view of the system may make this process easier because the technique can be alternated by the objectivity of the product itself, and the biological aspect is the subjectivity of human users. Similarly, Lewalski (1988) concludes the definition of form using system analysis as well, saying “industrial form is a set of external entries and exits of the technical system of the product which, in the process of the product’s utilization, come into relationship with its user’s biological system” (p. 145). Thus, the form covers the most important part in designing a product, the interaction between consumer and product.

According to the study of Crilly, Moultrie, and Clarkson (2004), attractiveness of the product should be divided into objective properties and subjective properties:

Each object should have an ideal form such as certain lines, proportions, shapes and colors, which one should be considered attractive by everyone. Some examples of the Golden Section and Bauhaus school rules in architecture are used to explain that a number of aesthetic principles were developed to aid the production of pleasing designs, such as symmetry, regularity and harmony. However, only the objective properties of a design are insufficient to explain judgment of attractiveness. The consumers’ subjective experiences are also

important. The visual appeal of the product is also influenced by socio-cultural, socioeconomic, historical and technological factors (p. 556).

Therefore, form is a broad enough concept to include appearance elements in the study of value perception. Due to form including an objective and subjective system, and the interaction between them, form elements can combine with aesthetic elements to determine the factors that decide the attractiveness of product, and affect the value perception. The following research will use form to explain the factors regarding attractiveness or the visual appeal of the product.

2.6.2 Color

Human eyes can distinguish a limited spectrum of light; the interaction effect between light, eyes, and the brain forms the color. Color is not just an objective physical reflection of light, but it also consists of the psychological factors from humans. “Every reflected color exhibits for basic properties: a selective spectral reflectance, or hue; a percentage of totally reflected or absorbed light, or value; a degree of reflected purity, or intensity; and a feeling of warmness and/or coolness, or temperature” (Lambert, 1991, p. 26).

“Colors have many psychological and visual effects, both positive and negative” (Niku, 2009, p. 319). For instance, many people use warm or cool to describe their perception of colors. The blue, purple, and green colors usually make people calm and peaceful; they are cool colors because they remind people of the image of winter or autumn. In contrast, the red, orange, and yellow colors normally evokes the memory of fire or sunshine, so they are warm colors. The perception of colors is different for

different individuals; even the visibility of colors varies in different groups of people. For example, according to Niku (2009), shown in Table 1, the sequence of color visibility on white background is different for men and women, with the first visible color black for men, and red for women (p. 319).

In addition, there are some commonly-used color rules that are usable for most people. The red color is often used in the traffic sign to draw attention, because red has the maximum range of visibility, 3.5 miles distance, as shown in Table 1.

Color Preferences	For men: Blue, red, violet, green, orange, yellow For children: Orange, red, blue, green, violet, yellow For women: Red, blue, violet, green, orange, yellow
Color Visibility	To men: Black, red, green (all on white background) To women: Red, green, black (all on white background)
Maximum Range of Visibility	Red: 3.5 miles Green: 3 miles White: 2.5 miles Yellow: 1.5 miles Blue, violet: 0.75 miles

Table 1. Sample of Some Visual Effects of Colors (Niku, 2009, p. 319)

Analysis of the value perception of colors in products needs to be based on the psychological effects of color. A different color will bring various psychological perceptions, specifically, depending on individual difference, but generally perceptions can be classified by different groups of cultures or countries. Table 2 shows the color perceptions in contextual differences, and demonstrates color effects in most cultures.

Color	Mood Created	Sample Association
Red	Stimulating; positive	Fire, danger, blood, stop, hot, left

Yellow	Cheerful, warm, outgoing	Sun, caution
Orange	Like red	Heat
Yellow green	Neutral	
Green	Restful, cool, serene	Nature, vegetation, go
Blue	Opposite of red, cool, subduing	Sky, water
Purple	Solemnity	Royalty, mourning
White	Neutral to positive effects	Snow, marriage, purity, (death in China)
Gray	Neutral, contemplation	Overcast
Black	Neutral, sorrow	Death, darkness

Table 2. Colors and Their Psychological Associations and Effects (Niku, 2009, p. 320)

In addition, Beasley and Palmer (1986) mentioned the similar psychology of colors, which can be seen in Table 3.

Red and Yellow	Existing and stimulating
Red	Aggressive
Yellow	Vitality also envy and cowardice
Blues and greens	Cool and receding
Blue	Peace, calm, serenity also sadness and grief
Green	Spring, hope, renewal also jealousy
Purple	Rank and authority also depression and rage
Black	Darkness and death
White	Purity

Table 3. Psychological Colors (Beasley and Palmer, 1986, p. 5)

Furthermore, Graves (1951) in the book *The Art of Color and Design* analyzes the characteristics and symbolism of color. Following his study, the current work

concludes the information shown in Table 4. Compared with the information in Table 2 and Table 3, the contextual difference color is more obvious in Table 4.

Color	Characteristics	Symbolism and Association
Yellow	Most luminous, least popular (particularly the darker shades)	Pleasant: Bright color yellow: cheerful, lively, sacred (in China and Western Christian civilization). Unpleasant: darker, neutralized, and greenish yellow (such as Y 8/1, Y5/4, Y2/2): the most unpopular and disliked color: sickness, indecency, cowardice, jealousy, envy, deceit, and treachery
Red	Greatest power of attention, most popular, positive, aggressive, and exciting	Rage and strife, danger, courage, virility, and sex Marriage (in China), martyrdom for faith (in Occidental religion)
Purple	Stately, rich, pompous, and impressive	Royalty (combine the properties of red and blue)
Violet	Cool, negative, and retiring	Penitence of saints (as a religious symbol)
Blue	Cool, serene, passive, and tranquil	Sincerity, hope, and serenity (with the church); fidelity
Green	Neutral, passive, most restful of colors	Freshness, raw, callow youth, and immaturity; symbol of peace (the olive branch)
White	Positive and stimulating, luminous, airy, light, and delicate	Purity, chastity, innocence, and truth; bereavement (in China); marriage (in Western Culture)
Middle Gray	Ideal background for most colors, mellow, pleasing	Sedate, sober old age
Black	Subdued, depressing, solemn, and profound	Sorrow, gloom, and death; secrecy, terror, and evil

Table 4. Characteristics and Symbolism of Color

The macro theory of color psychology will help designers to control the perception of consumers. For example, due to the association of red with stopping, the power switch usually uses red color to grab attention. Because of the renewal cognition

of green, many energy indicator lights use a green color.

2.6.3 Lines and Shape

“Lines can be defined as a mathematical entity with characteristics such as length, direction, and shape (straight, curved, skew lines, etc.), or as an aesthetic component with potent emotional value” (Niku, 2009, p. 314). As an element of the form, a line or shape is much like an abstract symbol of the three-dimensional product. “Because of this subtle simplicity, it is perhaps the most difficult of the elements to analyze” (Graves, 1951, p. 201). Therefore, the following discussion will focus on the perception or association of lines and shapes in three-dimensional products. Grave (1951) defines “the specific character and expressive symbol of each line:

- To most people the straight line suggests rigidity and precision. It is positive, direct, tense, stiff, uncompromising, harsh, hard, unyielding.
- The slightly curved or undulating line is loose and flexible. Because of harmonic transition in the change of direction, it has flowing continuity. Its slow, lazy movement is passive, gentle, feminine, soft, voluptuous. But the excessive use of this line creates an aimless, vague, or wandering effect.
- The more vigorously curved line changes direction rapidly. This curve is active and forceful.
- The arc or segment of a circle has an equal and constant change of direction. Because of this repetition, it is the most unified of curves but also the most monotonous and uninteresting, because of lack of variety. The spiraling curves seen in living, growing things are more dynamic.

- The zigzag, jagged, or crooked line with its sudden, abrupt change of direction, is nervous and jerky. The line is excited, erratic; it suggests electrical energy or lightning, agitated activity or conflict, battle, and violence” (p. 202).

In another similar study from Zelanski and Fisher (1987), the authors describe the “emotional qualities of lines:

- Rough or jagged lines or lines that go in many different directions convey a feeling of emotional upheaval.
- Curving lines remind us of flowing motion. The use of many curving lines may evoke a sense of romance or playfulness.
- Horizontal lines often carry a restful, secure feeling.
- Lines that are predominantly vertical do not convey this feeling of stability unless they are anchored in strong horizontal lines.
- Diagonal lines introduce a feeling of drama or energy” (p. 128-130).



Figure 5. Odate’s “Pride of New England” (Olender, 1982)

Using the line qualities from Zelanski and Fisher (1987) to analyze the wood work of Japanese Shoji maker, Toshio Odate, one can see that this wood work combines

various kinds of lines. “Lines in nature are rarely perfectly straight, but through balanced use of repetition and contrast, Odate unifies the straight lines of manufactured lumber with the curving lines of organic forms” (Zelanski & Fisher, 1987, p. 131).

In addition, Bevlin (1994) mentioned that a simple unified design in contemporary life used the lines as the total form, especially the taste of simplicity, lightness, and lack of decoration in furniture design (p. 62). As shown in Figure 6, the Zig Zag chair is designed by Gerrit Thomas Rietveld, and is made of natural cherry wood, with only four panels bent together. Seen from the side, this chair consists of four straight lines to form a very simple integration. It shows that, in product design, a simple line combination will create a style of simplicity.



Figure 6. Zig Zag Chair, designed by Gerrit Thomas Rietveld (IMad, 2012)

In addition to the lines, different kinds of shape will evoke the perception or memories of consumers as well. Bevlin (1994) categorizes shapes into natural, geometric,

abstract, and nonobjective shapes (p. 80). Natural shapes are usually from the natural environment, such as animals, plants, or human figures. The geometric shape is from nature as well, but is more fundamental, such as square, triangle, and roundness. The shape is not limited to the plane or surface; it can be three-dimensional, and consists of the form of the product, like in design bionics. Design bionics is often used in vehicle design, like the streamlined form of the dolphin.

A shape consists of different lines, and the above literature researched most categories of lines. Thus, analyzing the perception or emotion or association of different lines will conclude the perception of shape, whether it is two-dimensional or three dimensional shapes in the product. In addition, using proper lines or shapes that meet the psychological needs of consumers will add perceived value to the product.

2.6.4 Texture

“Modern designers can be credited with reviving the use of textural variety for its aesthetic value in painting, architecture, interior design, sculpture, and industrial design” (Graves, 1951, p. 222). Texture usually relates to the material and color, because different materials will present various textures, and the wetness, dryness, roughness or smoothness of the same surface will appear different colors. The texture is not only what can be seen, but also includes the sense of touch or skin feelings. “The texture of a work is the surface characteristics we could feel if we touch it, its hardness, softness, bumpiness, smoothness, sharpness, furriness, or whatever” (Zelanski & Fisher, 1987, p. 133).

Texture usually includes the natural, worked, and visual texture, which is

mentioned by some literature (Zelanski & Fisher, 1987; Bevlin, 1994). The natural texture often means using materials that come from nature, but in industrial design or architecture, many natural materials have already been worked to form some different kinds of texture. The worked texture comes from “a material that may be carved, blasted, polished, ground, hammered, built up, or woven together for a number of different reasons” (Zelanski & Fisher, 1987, p. 137). The visual texture is considered with the perceptions of a certain object. For example, a smooth and curved sculpture looks like a very soft texture, but actually it is only made of marble and hard (Figure 7). “Many works present an optically perceived visual texture that does not correspond with the actual texture of the material” (Zelanski & Fisher, 1987, p. 141). Visual texture can also be used in product design, especially in a limited cost situation. For example, painting can change a rough surface to smooth, and bring a feeling of cleanliness and solidity.



Figure 7. Giovanni Strazza's Sculpture - 'The Veiled Virgin' At St. John's

(Schaunaman, 2015)

In addition, what are the perceptions or feelings of different textures for most

people? Bevin (1994) analyzes the symbolism of textures:

“To most of us, smooth textures seem cold and remote, something associated with hospitals and sterility, perhaps even ominous. Rough textures, on the other hand, denote warmth as in a stone fireplace in a ski lodge or gentle beauty as in a garden wall, places where we enjoy laying a hand, feeling the variations in surface” (p. 106).

The emotional perception of textures, like the symbolism of colors or other forms, brings forth different feelings by evoking the familiar memories or experiences of people, and depends on contextual differences. As a relevant area of materials, the textual study of value perception will be further analyzed in the later part of this review.

2.6.5 Material

In an attempt to add value perception for products, in the materials area, designers need to know the psychological expectations of consumers first, and know how to select the material for designers’ needs. The first step is listing the factors that designers need to consider in materials selection, and the second step combines the first step and the properties of various kinds of materials to make a choice. “There is an exceedingly large array of material choices available to the designer, from natural materials such as wood to man-made ones such as plastics, and from common materials like cement and steel to exotic superalloys and biomaterials” (Niku, 2009, p. 330). There are an enormous number of materials and many available tool books that analyze the properties of various kinds of materials, such as strength, hardness, and toughness. Thus, it is unnecessary to list all properties of all kinds of materials, and the most important

thing should be the methods or guidelines directing designers to choose the proper materials to influence the value perception of consumers.

Based on the study of Flurschein (1983), “the material selection for the man/machine interface includes materials and finishes selection. The material selection is a checklist of factors that in relevant areas for consideration in analyzing product or system as a whole, the basic design factors include:

- Function: A consideration of what a product must do will give general guidance on the class of materials which will be appropriate.
- Economic background: Including the costs that may influence both manufacturing processes and materials, such as work costs, raw material costs, frequency of replacement, etc.
- Production quantities and methods: The quantity of products to be produced in batches per year will affect the economic methods of production and hence materials.
- Basic structural requirements: Balancing the design requirements for the engineering, ergonomic and aesthetics aspects for performance, for reliability, and for mechanical structural needs against production quantities, processes and their consequential cost is the central dilemma in material selection.
- Marketing: The designer must assess customer expectations, and if possible produce a product that exceeds these, but not too far.
- Safety: Safety is fundamental, and material selection should always comply with the relevant standards and take into account foreseeable risks.

- Appearance: Appearance is an important aspect of interface materials, since it is affected by the immediate visible surface of components and by the forms in which the components can be manufactured.
- Control: There may be requirements in this field relevant to material selection, for example appropriate manual contact friction grip levels, impact resilience, or suitability for graphics display by forming the material or by superimposing a graphics process.
- Corrosion resistance: It's a major criterion for selection of materials, affecting performance, appearance, life, safety and maintenance.
- Weight: It can be an important factor, more especially with all forms of transport" (p. 175-177).

In addition to the basic design factors in material selection, there are environmental factors as well, such as temperature, weathering, and noise, which should be considered in material selection. However, considering the consumers' value perception, the main factors included in the checklist for designers should be the above basic design factors.

The finish selection is almost of the same importance as material selection. "The meaning of the word 'finish' as the impression we receive from looking at or touching the surface of a manufactured item. The suggestions on finishes selection that designers should consider are:

- Market appeal: Quality is, in fact, often measurable in terms of the way a company finishes its products, and the higher the standard, the more it suggests good performance.

- **Functional efficiency:** Finishes contribute to functional efficiency in many ways. They may be chosen according to the way in which they affect performance, by controlling friction between sliding surfaces, for example; or for their contribution to economic durability in terms of resistance to wear, corrosion and misuse.
- **Safety:** Finishes can affect safety in many ways, such as by providing non-slip and non-reflective surfaces and by differentiating between safe and unsafe areas through colors.
- **Cost:** Inevitably, the question of finishes raises the issue of cost. For example, the high-gloss paint finish is more costly to produce than a textured one, but no volume car producer has dared to depart from tradition, which suggests that customers are prepared to pay more for what they want, even when a cheaper alternative would bring practical advantages” (Flurschein, 1983, p. 196-204).

In conclusion, handling the properties of different kinds of materials is essential for designers, and checking the detailed data of materials can be realized by using handbooks. However, this article focuses on determining guidelines to direct designers, in the materials area, to figure out what materials should be chosen to design a higher or lower perceived value product, and what aspects should be considered in material selection. Although the value perception will be different for various consumers, meeting the needs or expectations of consumers will add value to the product.

2.6.6 The Principles of Design

“In the visual arts the forms resulting from certain relationships of the elements, such as repetition, harmony, contrast, and unity, are essentially identical with the forms in the arts” (Graves, 1951, p. 17). The principles of design are a law of the effects that the form elements, including color, line and shape, texture, and materials, combine with each other. Although the principles are usually applied in the visual art, architecture, patterns, and sculpture, the order or law of the elements of form is still the great problem for industrial designers to resolve. “The challenge to the designer is to solve a set of functional and aesthetic requirements (‘the problem’) by assembling these parts into a whole” (Faimon & Weigand, 2004). This section will try to find the rules that are usable in product design from these principles. Based on the structure of the design principles of Bevin (1994), the principles of product design will be unity and variety, balance, proportion and scale.

- *Unity and Variety.* “Briefly stated, unity is the cohesion, consistency, oneness, or integrity that is the prime essential of composition” (Graves, 1951, p. 90). According to Faimon and Weigand (2004), unity is the quality of sameness, and variety is the quality of absence of monotony or sameness (p. 26). Unity is in order, but sometimes is boring, and variety is complex or disorderly but can be fun. Thus, keeping the balance between unity and variety is very significant. How does one keep the balance? Graves (1951) mentioned that the unified of style of character, dominance of interval or major contrast, or repetition can draw unity (p. 97-108). For example, the table and chair set are made of same wood material; the same smooth texture, same color, and the repetitious use of the same curve keep the stylistic unity

(Figure 8). From the examples of Faimon and Weigand (2004), the balance of unity and variety might be achieved by integrality of simple design, and grouping parts together. The grouping includes like parts, common elements, proximity, overlapping parts, common ground, and borders (p. 31-47).



Figure 8. Wooden Dining Tables And Chairs set (Table and Chair Set, n.d.)

- *Balance*. The term *balance* means visual balance. “Factors such as value, texture, form, size, and color affect our perception of visual weight. For example, light colors appear lighter in weight than dark colors; transparent areas seem to weigh less than opaque areas. One way of creating balance is through the use of symmetry, or mirrorlike replication of parts around a visual axis. Sometimes designers deliberately create unbalanced works to attract attention” (Zelanski & Fisher, 1987, p. 68; Faimon & Weigand, 2004, p. 105; Bevlin, 1994, p. 150). Therefore, balance can be created by symmetry or equal visual weight, and imbalance achieved by asymmetry will attract attention.
- *Proportion and Scale*. Proportion is not just the size. “Proportion is the

relationship of sizes within an entity or composition, while scale is measured according to an outside unit of measurement” (Bevlin, 1994, p. 175). In proportion analysis, the Golden Section and Spiral are found by Greeks to reach a pleasing or aesthetical proportion (Figure 9). Besides, according to Zelanski and Fisher (1987), using familiar proportions, such as a human figure, will help viewers make sense of the piece (p. 74). These natural rules reflecting the feelings of proportion will encourage different perceptions of products. The scale can be a measurement relationship between product and people, or environment. “The scale and proportions of a pitcher or a teapot must be easy to handle, a piece of movable equipment like a power tool or a kitchen appliance must also be easy to use and scale with the task for which it is designed” (Bevlin, 1994, p. 174).

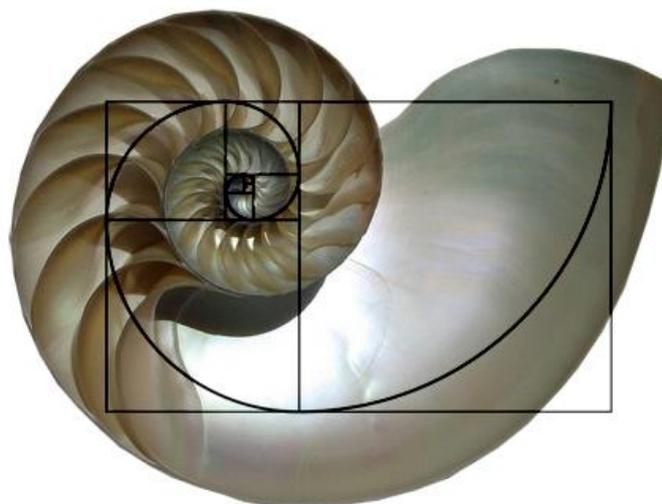


Figure 9. The golden spiral and ratio is a set of proportions that fit into almost any natural structure. (The Fibonacci sequence, Golden Ratio, and Golden Spiral, 2013)

Thus, the principles of design can be applied to product design as well, and following the related rules will help the designers to control the value perception depending on the consumer's needs.

According to the literature above, form can be classified into color, line and shape, texture, and material. In addition, the principle of design includes unity and variety, balance, proportion and scale. On the fundamental side, all these factors of forms need to be controlled by designers, and all these factors will affect the consumers' value perception. Therefore, analyzing form's influence on the value perception, designers should follow these categories and principles, and check all the relative effects for different consumers' needs towards certain products.

2.7 The Function and QFD Method in Product Design

“Functions are the ‘what’ of a product, describing what the product is to accomplish” (Gause & Weinberg, 1989, p. 149). What consumers intend to use the product for, or what consumers want to do with the product, determines the basic functions of a certain product. For instance, the original purpose of the water bottle is containing water and drinking, so the basic function of water bottle should be a container. The significance of product should be the practicability, or functional quality for users, and then users create the product and its functions. “The functional value of a product pertains to the utilitarian functions a product can perform (its use)” (Creusen & Schoormans, 2005, p. 67). Therefore, a product that has useful functions will be valuable for consumers, whether the product is created for aesthetic or operation. In other words,

the function should meet consumer demands, and satisfying consumers' needs - will add to the consumers' value perception to the product.

At the early stages of the design process, designers need to figure out what the customer wants the product to be, and further determine the functions of the product. There is an available method used for “analyzing the needs of customers and deciding what features to include as well as linking the needs of customers to the design of the product and its functions” (Niku, 2009, p. 124); the Quality Function Deployment (QFD) method. Akao (1990) defined the QFD as:

“converting the consumers' demands into ‘quality characteristics’ and developing a design quality for the finished product by systematically deploying the relationships between the demands and the characteristics, starting with the quality of each functional component and extending the deployment to the quality of each part and process” (p. 5).

In this thesis, the aim is to apply the QFD method to product design, and analyze how to find the functions that consumers need. The necessary functions meeting customer demands will add to consumers' value perception, and conversely unnecessary functions will reduce the perceived value of the product. Applying the outline of QFD to product design, taken from Akao (1990), given here is the “outline of developing the Quality Plan and Quality Design:

1. First, survey both the expressed and latent quality demands of consumers in your target marketplace. Then decide what kind of ‘things’ to make.
2. Study the other important characteristics of your target market and make a demanded QFD chart.

3. Conduct an analysis of competing products on the market, a competitive analysis. Develop a quality plan and determine the selling features.
4. Determine the degree of importance of each demanded quality.
5. List the quality elements and make a quality elements deployment chart.
6. Make a quality chart by combining the demanded quality deployment chart and the quality elements deployment chart.
7. Conduct an analysis of competing products to see how other companies perform in relation to each of these quality elements.
8. Analyze customer complaints.
9. Determine the most important quality elements as indicated by customer quality demands and complaints.
10. Determine the specific design quality by studying the quality characteristics and converting them into quality elements.
11. Determine the quality assurance method and the test methods” (p. 7-8).

Taken from the QFD method, how to analyze the quality in product, firstly, one can conclude that various kinds of charts accomplished this outline, such as quality elements deployment chart, QFD chart, quality plan chart, etc. However, it is unnecessary to study all the charts and methods in QFD, because this literature is intended to be used as a basic theory to form “how to direct designers to conclude the functions that consumers need.” Secondly, an idea that should be noted is that the “quality” in this QFD outline is not the function of consumer need, but the function is directly coming from the “quality.” Thus, the functions that add value perception can be determined from this outline.

There is another similar list in the QFD method, which is established from the QFD Product Planning Matrix (an example in Figure 10), mentioned by Niku (2009):

1. “Identify the real customers.
2. Collect information about customer wants, needs, desires, and preferences.
3. Assign priorities (importance, weight factor) to each requirement based on customer feedback, customer psychology, or estimates.
4. List the design specifications and features of your product.
5. Benchmarking your competition. Determine how well each requirement is satisfied with the current product (if any) and by competitors.
6. Determine the relevancy of each feature to each customer requirement.
7. Determine interactions and compromises. You must determine whether fulfilling each specification may have a positive or negative effect on the other specification.
8. Set engineering target and benchmarks. You should look at the benchmarks, your competition, the degree of difficulty, and the summations of weight factors multiplied by relevancy factors, in order to draw conclusions about what should be done, what target you should strive to achieve, and what specifications you must set for your product” (p. 128-129).

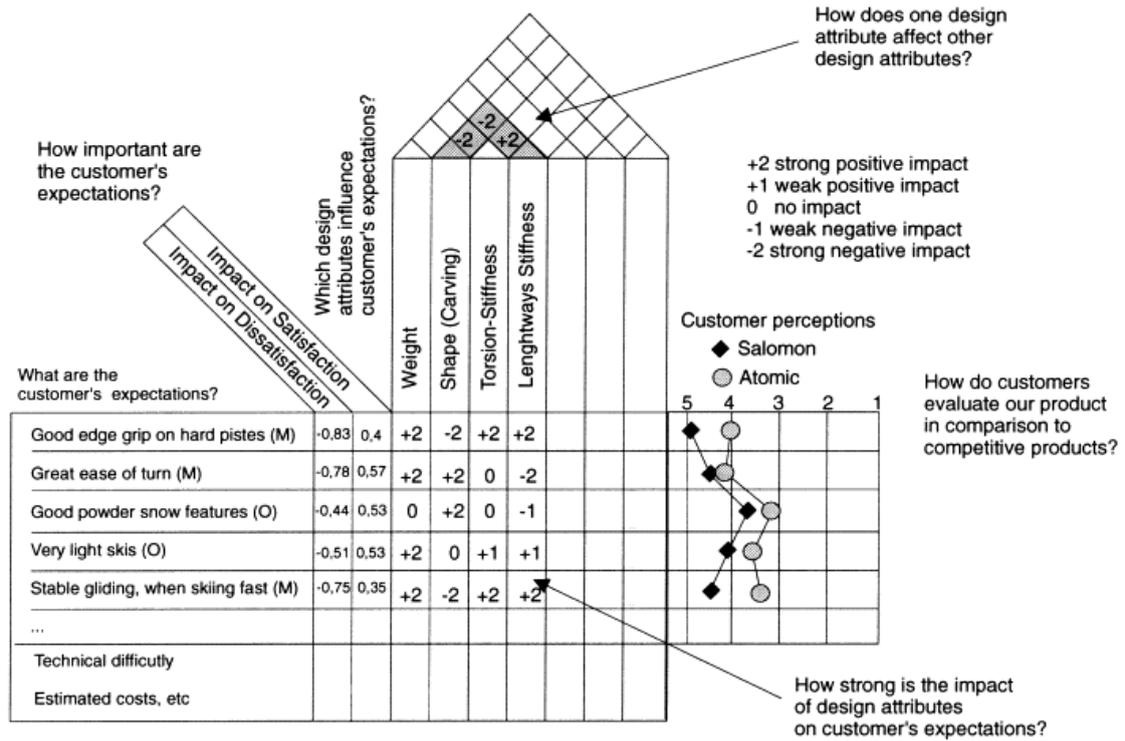


Figure 10. The House of Quality (QFD Product Planning Matrix of Skis

Design Analysis). (Matzler & Hinterhuber, 1998, p. 36)

The Product Planning Matrix is a significant table used in the QFD method that shows the customer wants, weight factors, product features, relationship matrix, benchmarks, and engineering targets and benchmarks (Figure 10). Using this table will make it easy to find the relationship between different features, figure out the priority of features, and finally help to decide the valuable functions the product should have. In addition, the Product Planning Matrix is formulated by the list (Niku, 2009) above. Thus, the outline is a detailed interpretation of the Matrix, and following the outline will be helpful to determine the valuable functions of products.

Finally, combining these two outlines will summarize the final guidelines of how to figure out the necessary and unnecessary features for consumers, and help designers to further create the functions that consumers perceive as high or low value.

2.8 The Human Factors

“Designers may be primarily concerned with how well equipment functions or how a product’s appearance might affect its marketability, but such emphases may not necessarily include important human factors considerations” (Burgess, 1989, p. 53). Human factors is a separate study, and initially comes from the design of military equipment. In the human-machine system, researchers find the significance of the interaction with machines. One of the definitions is “human factors, also known as ergonomics, is the study of the measurements, capabilities, and limitations of the human body and how the humans and machines interact with each other” (Niku, 2009, p. 254). Another similar but more detailed definition is, “Human factors and ergonomics are concerned with adapting products to people, based upon their physiological and psychological capacities and limitations” (Stanton, 1998, p. 1). Thus, study of human factors is used for improving the performance of the human-machine system, which includes physiological and psychological aspects. In the current work, the main purpose is to help designers control the value perception of consumers. The performance of interaction between products and consumers will obviously influence the perceived value. More specifically, the perceived value of consumers reflects the human factors area in whether the product is easy to operate or looks easy to operate, and cause a satisfied feeling.

In most cases, consumers need to operate the product and then make an evaluation about it. However, “as consumers often cannot try out products in a shop or when buying on the Internet, they will use the product appearance to form an indication

of the ergonomic product value” (Creusen & Schoormans, 2005, p. 68). The appearance, or the visual performance of the product, also has an effect on the product value in the human factors aspect, and influences the consumer perception of ease of use. However, this perception can be different from the reality. “For example, an upright-shaped product may be designed in such a way that it cannot fall over in normal use, but consumers may conclude that it is not stable after seeing it” (Creusen & Schoormans, 2005, p. 68). When consumers make purchase choices, the “looks easy to use” consideration will mainly influence the value perception about a product due to the first impression.

2.8.1 Physiological Characteristics of Humans

The most important part of physiological factors in human factors is the anthropometric data. “Anthropometric data is the collection of the measured physical dimensions, capabilities, and limitations of the human body, including the strength of the human musculoskeletal system under different conditions and configurations” (Niku, 2009, p. 255). Anthropometric data are mainly used for helping designers to decide the appropriate dimensions of products and find the range of dimensions in which consumers can operate a product comfortably and safely.

There is a series of practical strategies for considering the body size of a consumer, based on the Anthropometric Design Strategies of Burgess (1989):

- “Designing for the Median: This also means designing for the average or mean size of a user population. Cabinets, tables, and other furniture, for example, might be simply too costly to design for a complete range of user

sizes from the extremely small to the extremely large.

- **Designing for Extremes:** This design strategy is commonly used. The upper and lower limits are accommodated; thus, the height of a door designed for the largest body size would accommodate all smaller sizes.
- **An Adjustability Strategy:** This is, perhaps, the best design approach and should be used whenever possible. It simply provides for an adjustable range of body sizes, such as seat height, helmet diameters, etc. In military equipment design, the range between the 5th and 9th percentiles is generally used. This avoids overly-costly adjustments while providing for the most convenient use by 90 percent of the population.
- **A Full-Range Strategy:** Designing for the accommodation of the complete range of population body sizes may sometimes be possible and desirable. In fact, such a design strategy may be particularly pertinent where survival operations are involved, as in the case of handholds and outside dimensions of escape chutes and hatches” (p. 36-37).

These strategies should be a choice by designers depending on the target consumer groups and the category of products. The following is an example to analyze how to use the anthropometric data and strategies properly.

As shown in Figure 11 and Table 5, (A) Eye height sitting, (B) Elbow rest height (C), Forearm-hand length, (D) Buttock-popliteal length, (E) Buttock-knee length (F) Popliteal height - no shoes, (G) Knee height sitting - no shoes. These anthropometric data are used for designing workstations, and designers should primarily collect data and apply the proper dimension depending on the target consumer group. For instance, if the

workstation should be suitable for most adult people, designers can choose the “Adjustability Strategy”. The eye height sitting (A) should be adjustable from 690mm to 850mm. Thus the chair height may be adjusted to fit most body sizes, and the table height and the monitor angle should be considered to match the range of chair height.

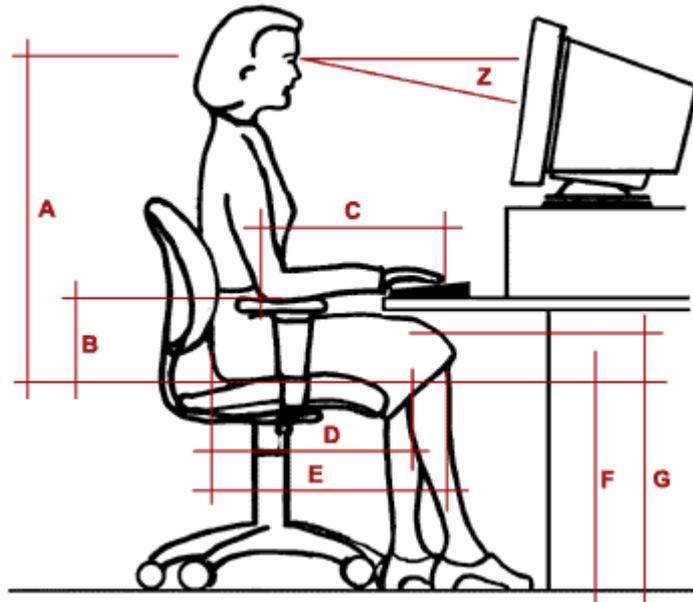


Figure 11. Anthropometric and Economic Data of Workstation Design

(Ergonomics for Designers, 2014)

#	Female			Male		
	5%	50%	95%	5%	50%	95%
A	690	743	795	739	795	850
B	181	226	266	188	235	274
C	406	439	479	447	482	520
D	438	478	525	458	499	544
E	540	585	637	569	616	665
F	352	388	428	395	434	476
G	474	513	558	515	559	605

Table 5. Anthropometric and Economic Data of Workstation Design (All measurements in mm). (Ergonomics for Designers, 2014)

2.8.2 Psychological Characteristics of Humans

“Psychological factors include learning curves, boredom, mental fatigue, attention span, fear, and other stressors. These factors can play a significant role in the way a product is perceived or understood, and consequently, the way it is used” (Niku, 2009, p. 294). In other words, the psychological reaction of the consumer, or the cognition of users will be influenced by the product, and the cognition of users will have an effect on their value perception or value evaluation of the product.

- Learning Curves, Boredom, Mental Fatigue, and Attention Span: Niku (2009) applied a typical learning curve to explain the psychological factors. When meeting a new product, it is a learning process for humans to figure out how to use it. In Figure 12, the typical learning curve shows this process with increasing time. At the beginning, it is hard and slow to learn the new knowledge, so it will take a period of time. As time increases and the operation become easier to perform, it becomes less challenging and boring. A repetitive operation will cause boredom, and mental fatigue (p. 296). Therefore, if the functions of the product are too simple, it will cause consumers’ boredom, mental fatigue, and reduce attention. On the contrary, if the functions are too complex, the consumers will be tired and careless. “It is imperative that the designer always considers the correct balance between how difficult an operation is, how much learning is necessary,

whether there is enough challenge to keep the mind interested without fatigue, and whether or not there are enough variations in the task to keep it interesting” (Niku, 2009, p. 297).

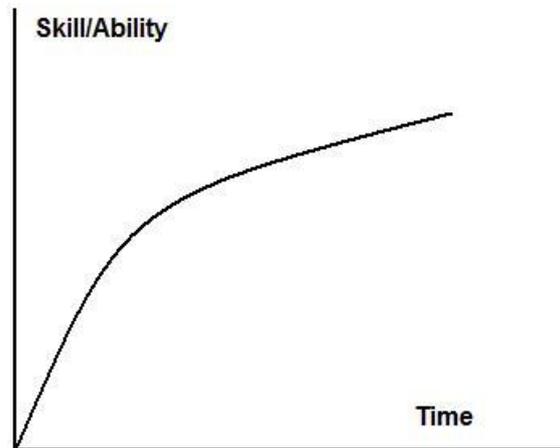


Figure 12. The Learning Curve (Minkey, 2013)

- Stressors and Fear: “Stressors are factors that create a stressful situation. They include danger, fear, anxiety, competition, crowding, and information overload” (Niku, 2009, p. 294). People may reflect positive or negative reaction when facing stressors, and these reactions will cause different operations for the same function of the product. For instance, toy designers should consider the situation that children may swallow the little part of the toy and choke themselves, especially for the age under three. Thus, the toy for under-three children should be designed to be big enough to prevent this situation, or be labeled “choking hazard” on the package. This psychological factor will also relate to product liability and product safety, which is discussed in the next section. “A good designer will consider these situations and will create appropriate safeguards to prevent dangerous situations, and eliminate, contain, or reduce the consequences of the inevitable dangerous

situations that may relate to the product or system” (Niku, 2009, p. 296).

2.8.3 Product Safety

Obviously, designers should consider design safety and prevent or reduce product hazards. As mentioned by Burgess (1989), there is a consumer study commission that was established to protect consumers against product hazards, the Consumer Product Safety Commission, which found that 20 million injuries occurred every year that could be attributed to unsafe product design (p. 171). In the study of human factors, the most common danger occurs through inappropriate operation by people. In product design, designers should consider the consumers’ ability and adaptability, and the possible dangers. Human factor analysis will help designers to improve their product in the safety aspect.

The first level in product safety should be hazard recognition, which is figuring out the possible danger of product or equipment. According to Niku (2009), hazard recognition should include:

- “Kinematic Hazards: Includes rotating machinery, moving elements such as linkages and chain drives, and nip points (points where a moving element comes close to a nonmoving element). Body parts, such as fingers, can get caught in nip points and easily be injured.
- Energy Hazards: Includes mechanical energy such as potential and kinetic energies (springs, flywheels, rotating elements), electrical energy such as batteries, capacitors, and AC power sources, chemical energy such as fuels and explosives, and microwave energy.

- **Electrical Hazards:** Includes electrical shocks, electrical shorts, electromagnetic fields (EMF), and electrical interference between different devices.
- **Chemical Hazards:** Includes toxins, chemical reactions between different materials, oils, vapors, interference between different materials, oxidation, and other chemical interference.
- **Material Hazards:** Includes reactions among different materials, toxic materials, hazardous material, and material-handling issues.
- **Environmental Hazards:** Includes noise and noise levels, lighting, ultraviolet (UVA and UVB) rays, bacteria, viruses, fungi and yeast, oxidation and fading of materials and colors. It also includes the effects of the product or system on the environment, including air pollution, water pollution, solid waste, product's end-of-life issues, and recycling issues.
- **Human Factors Hazards:** Includes factors related to the physical, physiological, and psychological limitations and capabilities of humans as they deal with the product or system.
- **Misuse and Abuse:** Includes the unexpected but predictable uses of the product, unintended uses and abuses of the product or system, and possible mistakes that the users may make” (p. 297-298).

The second level in considering the safety of product design, especially for designers, should be how to eliminate product hazards. The following methods mentioned by Niku (2009) are the ones for hazard elimination:

- “Human Factors Considerations: The hazard may be eliminated by inclusion

or integration of human factors into the design.

- **Design Change:** If the hazard cannot be adequately contained or controlled, a design change may be necessary.
- **Safety Devices:** At times, it may be adequate to add safety devices to a product.
- **Guards, Switches, etc.:** It is unlawful to leave rotating machinery without guards, even if the machine was designed and manufactured in the past.
- **Warnings and Instructions:** It may also be possible to adequately safeguard a hazard by warnings” (p. 298-299).

Some of the hazards or elimination methods cannot be decided only by designers; however, designers should consider as much as possible dangers that may occur in the operation process, and apply these principles to improve their products for consumer needs.

2.8.4 Human Factors Data Sources

There are numerous human factors data, especially anthropometric data. It is unnecessary to list all the data that designers need to apply to product design. For designers, data collection ability is more significant.

Firstly, “the human factors researcher compiles data from many professional fields and information sources. These include performance tests, physical measurements of humans, task observations, and surveys” (Tillman & Tillman, 1991, p. 37). This research collects data and further analyze it to develop the guidelines or instructions that can be used by designers or engineers.

Secondly, according to Tillman and Tillman (1991), for the designer, valid specific information can be collected from these three paths:

- “Research Reports: Research reports contain both results and research techniques. Some research projects answer a specific design problem and the designer can apply the research results directly to a design.
- Human Factors Design Handbooks: Design handbooks and guidelines condense human factors research results and studies that are applicable to designs. Design guidelines are constantly updated and expanded.
- Human Factors Design Standards: Human factors design standards exist for many government and commercial products. Some organizations that have developed or use human factors design standards are the Department of Defense, NASA, and the Society of Automotive Engineers” (p. 43).

For designers, related reports, handbooks and guidelines usually can be found in the library, and the standards of human factors can be checked on some government website or publications. The most recent available data will be more effective.

2.9 The Contextual Difference

According to Monroe (1977), there is a category concerning how to study contextual information. When people decide to purchase objects, the price is influenced by immediate contextual information, memory contextual information, purpose or use of purchase, and income or budget context (p. 294-295). Due to the relationship between price and value mentioned previously in Figure 1, context research on price can be a reference of value perception. The purchase choice process reflects the consumers’

perception of value or price or quality; their evaluations or judgments are influenced by their contextual difference, or cultural context variety. “The culture, background and experiences of the consumer are influential in determining their response to products. The designers and consumers of a given product are often (but not always) separated by time, place or social group” (Crilly, Moultrie, & Clarkson, 2004, p. 554). As mentioned before, the primary things in considering how to add value (or perceived value) to the product, in the designing process, is to meet consumer needs. Thus, consumer differences must be discussed. The different consumer groups vary in value perception due to different cultures and subcultures. In the study of Engel, Blackwell, & Miniard (1990), Culture and Subculture also mean Macroculture and Microculture, and these terms “refer to a set of values, ideas, artifacts, and other meaningful symbols that help individuals communicate, interpret, and evaluate as members of society” (p. 63). Therefore, the contextual difference will be analyzed from two aspects, culture and sub-

culture.



Figure 13. The comparison between Traditional Chinese bedroom and European bedroom. (Traditional Bedroom, n.d.; Modern Furniture, n.d.).

As designers, designing products based on contextual differences will be very significant. “Design preference may be largely moderated by cultural agreements on ‘what looks good...what materials are to be valued...what is worth aspiring towards and how aspirations can be reinforced with material goods’ ” (Crilly, Moultrie, & Clarkson, 2004, p. 572). Culture differences will influence aesthetic trends and fashions, and further determine consumers’ purchase choices. For instance, as shown in Figure 13, Chinese bedroom décor is totally different from European bedroom decoration, although they are both luxurious and traditional. For the majority of members of western culture, people will choose the European style, while the Chinese bedroom will be more acceptable to Chinese people. Thus, the interior designer needs to design based on the

different cultural groups.

2.9.1 Culture in Contextual Difference

“Culture is the collective programming of the mind which distinguishes the members of one group or category of people from another. Culture is learned, not inherited. It derives from one’s social environment, not from one’s genes” (Stanton, 1998, p. 180). It is unnecessary to analyze the personal or individual difference in product design, because most industrial products just need to satisfy the target consumer group, not the one person. Culture distinguishes the different consumer groups rather than individuals.

Discussed by Engel, Blackwell, and Miniard (1990), culture, or macroculture, refers to the sets of values and symbols that apply to an entire society, and the society refers to social systems, such as a nation or even Western civilization (p. 63-64). Based on their research, some of the cultural aspects that are related to value perception include core values, and different cultural values.

- **Core Value:** The core value means the comprehension of most people of the value of a product in a society. “Core values define how products are used in a society” (Engel, Blackwell, & Miniard, 1990, p. 67). And that understanding will vary depending on the different culture. For example, many American people like to eat cereal or toast and drink cow milk in the morning. In China, many people prefer to eat a traditional breakfast, a kind of fried bread stick, and drink soybean milk. The traditional soybean milk differs from American soy milk, because it is made of soybean and water,

with no milk inside. This is a core value. How does the core value apply to product design? Based on the Chinese breakfast tradition, Joyoung Company sells a Soy Milk Maker that focuses on the Chinese breakfast market (Figure 14). This Soy Milk Maker sells very well in the Chinese market, and almost every family needs one, because it meets the Chinese people needs for breakfast. However, it is hard to achieve the same success in the American market.



Figure 14. Joyoung Soymilk Maker and Chinese Traditional Breakfast

(SoyaJoy, n.d.; Soy, n.d.)

- Different Culture Value: As analysis on the breakfast difference between Chinese and American culture shows, different values emerge from cultural variety. Designers need to consider the core value or value perception of target consumers in different cultural environments. The culture differences are usually classified by countries and regions, and can be sub-divided to sub-cultures as needed. For example, Engel, Blackwell, and Miniard (1990) divided American culture into subgroups of American values, Asian American culture, Black culture, Hispanic Culture, and French-Canadian

culture (p. xviii). The different cultural values reflected in design can be the variety of aesthetic preferences, fashion trends, function needs, etc.

2.9.2 Subculture in Contextual Difference

Several subcultures constitute a national culture, and more specifically. “A national culture is made up of several sub-cultures which have their own distinctive characteristics, some of which may be very different from the total pattern of culture” (Chisnall, 1975, p. 98). In addition, Chisnall (1975) identified some sub-cultures, such as age (youth and adult), ethnic, religious, physical, or social sources (p. 98). In another similar consumer behavior study, “some of the more common bases for identifying subcultures are regions, nationality, ethnic origin, religion, age and sex” (Walters & Bergiel, 1989, p. 253). Therefore, drawing from these sub-culture definitions, microculture should include ethnic, religious, social class, age and gender. When discussing the subculture factors, designers should consider them within one certain macroculture, such as American culture, Asian culture, or Western civilization.

- Ethnicity: Race and ethnicity are very important aspects in sub-cultures. “Knowledge of the particularities of major subcultures helps in explaining differences in search and buying patterns among consumers” (Walters & Bergiel, 1989, p. 262). Walters and Bergiel (1989) also give some examples to explain the differences. For example, the Hispanic subculture includes the Mexican-Americans (61.2 percent), Puerto Ricans (13.5 percent), and other (25.3 percent). In the purchase analysis, members tended to maintain their Spanish language, and this causes some problems. Focusing on these

consumers, some companies such as Procter and Gambler, Chrysler, and Pepsi-Cola penetrated the Hispanic subculture with Spanish language mass media appeals (p. 262-263). In another example mentioned by Chisnall (1975), as shown in Table 6, African American consumers preferred to buy a higher percentage of more expensive cars than white consumers (p. 100). These results suggest these two ethnicities have different value perceptions for car purchases. Thus, designers need to improve their product depending on the different consumer ethnic groups.

Price Class	African American (%)	White (%)
Foreign	1	3
Low Price	50	61
Medium Price	42	34
High Price	7	2
	100	100
	(300)	(300)

Table 6. African American and White Car-Buying Behavior. (Chisnall, 1975, p. 101)

- Religious: “Religious groups affect consumer search and purchase in three ways. First, they have a strong influence on consumer ethics and morality. Second, they have an influence through the sale of products that have religious symbolism, such as crosses, beads, statues, and incense, and products associated with religious holidays. Third, religion has a strong influence on search and purchase because of the association of buying with such holidays as Christmas and Easter” (Walters & Bergiel, 1989, p. 267).
- Social Class: There are many analyses in the marketing area about social

class. Obviously, the level of income will directly influence a consumer's purchasing power. However, social class cannot simply be decided by income, but it also includes education and occupation, family background, residence, etc. Social class usually influences the acceptability of products. Mullen and Johnson (2013) give an example to explain that "innovations seem to be accepted to the extent that the innovations are compatible with the cultural attributes and lifestyle of the social classes. For example, television was more quickly accepted by the lower classes, while the card game Canasta was more quickly accepted by the higher classes."

- Age: Walters and Bergiel (1989) classified age as children under thirteen, the teenage group, young adults, and senior citizens, and pointed out their different preference in product purchase (p. 267-271). For example, "boy's toys tended to be colored in intense colors, such as red, blue, and black" (White, 2007, p. 17), but most adults will not like the colorful products. For the teenage group, for example, "it is extremely fluid, and things change so rapidly that products and fads can become obsolete almost overnight" (Walters & Bergiel, 1989, p. 271). For the young-adult example, "it is estimated that nearly 65 percent of young people from age sixteen to twenty-one are in college. College students are big spenders on wearing apparel, furnishings, books, and recreational equipment" (Walters & Bergiel, 1989, p. 271).
- Gender: The study of Moss (2009) summarized the result of several experiments which related to the comparison of male and female preferences

of visual elements in design (p. 172). In Table 7, the male and female preferences are different in many factors of form design or aesthetic trend, such as line and shapes, color, image, details, etc.

	Male productions and preferences	Female productions and preferences
Visual elements	Straight lines and shapes	Rounded lines and shapes
	Use of few and darker colors	Use of many and brighter colors
	Regular typography	Irregular typography
	3-D images	2-D images
	Lack of detail	Detail
	Images of men	Images of women
	Moving objects	Stationary objects

Table 7. Summary of the visual and linguistic difference between male and female (Moss, 2009, p. 172).

In conclusion, the higher perceived value product must meet consumer needs. Due to the different purchasing preferences of different groups of consumers, designers need to consider the contextual differences of consumers. In addition, the contextual difference can be classified by cultural and subcultural aspects. In the cultural aspect, designers need to figure out core values and distinguish the different culture values. In the sub-culture aspect, designers can consider product design from the five factors of ethnic, religious, social class, age and gender perspectives. Actually, in most situations, designers should combine all these contextual difference factors to define their target consumers, and further improve the product based on the target users' demands.

2.10 Other Factors

In addition to the form, function, human factors, and contextual difference, there

are other factors that influence consumers' value perception as well. However, these factors will not be analyzed in the guidelines, because they are hardly controlled or decided by product designers. These factors include time, brand, inherent values, services, and selling environment.

For instance, the aesthetic tendency and functions are different in past and present. As shown in Figure 15, the cell phone in the past was very big and had no screen, and only had one function, calling. The present cell phone has a bigger screen and is thinner, with more functions as well. That is because of the advance of technology and the changing of people's aesthetic tendencies.



Figure 15. Cellphones in the past and present (Two Cellphones, n.d.).

Brands greatly affect consumers' perceived value as well, and there is much literatures studying brand influences. But, as the brand factor cannot be decided by designers, designers need to follow the characteristics of the brand they are designing for. For example, the different car brands usually have their certain design style to distinguish from other cars.

Inherent value is very similar to the core value mentioned in the cultural

analysis in contextual difference. It is people permanent value of a society. Engel, Blackwell, and Miniard (1990) mentioned an example to explain this, using the word “compatibility” to explain the inherent value:

“Clairol introduced a new shampoo, called A Touch of Yogurt. It was unsuccessful, apparently because people found the idea of putting yogurt into their hair incompatible with their value systems, despite the fact that yogurt may be good for hair. Perhaps if the product had been called A Touch of Glamour, with Yogurt, it might have succeeded. Glamour is part of the norm of the target market even though yogurt in the hair is not” (p. 692).

All these factors, including environment factors like services, and selling environment, indeed, influence the consumers’ evaluation of the product. However, this thesis will focus on determining guidelines that direct designers to improve their product; thus, these other factors will not go into details about how these factors affect consumers’ value perception.

2.11 Conclusion

In the literature view, this article mainly analyzed the four primary factors that may influence consumers’ value perception; the form, the function, human factors, and contextual difference. Each primary factor is divided into several parts to detail how each one influences value of people. The guidelines will be determined on the basis of all the literature in this chapter, and designers need to consider all the related factors together and follow the guidelines given in Chapter 3.

CHAPTER 3

GUIDELINES

3.1 Design Guidelines Development

On the foundation of literature review, the design guidelines includes four main sections: Contextual Difference, Function, Form, and Human Factors.

1. Contextual Difference

First of all, in Contextual Difference analysis, designers should figure out the target user group of the product.

(1) Subculture:

A. Ethnicity, Social Class, and Age:

- As mentioned in the literature review, the Ethnicity can be a certain nation, or a certain race in a nation.
- The Social Class can be divided into low, middle, and high class.
- The Age factor includes children under thirteen, the teenage group, young adults, and senior citizens. For special products, the age group can be subdivided, such as infants, and elderly.

B. Religion and Gender:

There are two questions for designers to consider:

- Is the product designed for a certain religion?
- Is the product designed only for female or male?

If the answer is yes, then designers can be sure about the certain religion or gender. If no, the product should meet the demands of both religious people and

irreligious people, or both female or male.

(2) Culture:

The Core Value of society is various due to the different cultures. The Culture is a reference aspect for designers in considering all the Subculture factors. In the literature review, for example, the Soy Milk Maker is only popular for Chinese Culture. Thus, there is a final question for designers to consider in this section:

- Does the product designed consider a core value? What is it?

The purpose of Contextual Difference, is helping designers to narrow down the target user group, because in many circumstances, the consumer information that can be received from marketing department or clients is limited. Designers still need to narrow down the information by themselves, Table 8 shows the guidelines of how to get the specific and effective target user group information.

Table 8 is a chart for analyzing all the factors in contextual difference. Designers can follow steps one, two, and three to conclude the target user group.

Contextual Difference: Target User Group Analysis						
Subculture	1	Ethnicity	Nation			
			Race			
		Social Class	Low Class			
			Middle Class			
			High Class			
		Age	Children under Thirteen			
			Teenage Group			
			Young Adults			
	Senior Citizens					
	Special Age Group	Infant				
Elder						
2	Religion	Is the product designed for a certain religion?	No	Yes	What's the religion	
	Gender	Is the product designed only for female or male?	No	Yes	Female	Male
Culture	3	Core Value	Does the product designed consider a core value? What's it?			

Table 8. Target User Group Analysis

- (1) Based on the Target User Group concluded from the Contextual Difference:
designers should do target consumer research.
- (2) List all consumer's possible expectations and assign priorities.
- (3) List all design factors that influence consumer's expectations.
- (4) Analyze how strong the impact is of design factors of consumer's expectations by "0", "1", "2", "3".
- (5) Consider and analyze the relationship between Technical Difficulty, Processing Costs, and Design Factors.
- (6) Finish the Function Analysis Chart, concluding functions the product should have.

The Function Analysis Guidelines will help the designer to control the consumer wants, the important sequence of design factors, product functions, relationship of design factors and manufacturing factors.

3. Form

Form is related to the visual perceived value of the product to a large extent. Tables 9, 10, and 11 will help designers to design the product so that it "looks good" by controlling the consumers' value perception.

- (1) Lines and Shape:

The designer can choose the lines depending on the different value perceptions (Table 9) in their concept development, and use these lines to constitute shapes. The Table 9 is concluded from the emotion and association of lines and shapes in Chapter 2.

	Lines	Example	Symbol	Association & Emotion
Straight Lines	Horizontal lines: restful, secure feeling		Rigidity, precision	Positive, direct, tense, stiff, uncompromising, harsh, hard, unyielding
	Vertical lines: unstable (But when they are anchored in strong horizontal lines, they will be stable)			
	Diagonal Lines			A feeling of drama or energy
Curved Lines	Slightly curved & Undulating line		Loose, flexible, flowing motion	Passive, gentle, feminine, soft Excessive using: Aimless, vague, wandering; a sense of romance or playfulness
	More Vigorously curved line		Active, forceful	
	Arc & Segment of a circle		Equal and Constant	Most unified, but most monotonous and uninteresting
	Spiraling curves		Dynamic	Living, growing
	Zigzag, jagged, crooked lines		Sudden, abrupt, nervous, jerky	Excited, erratic, upheaval Electrical energy or lightning, agitated activity or conflict, battle, and violence

Table 9. Selection of Lines

The lines and shapes determine most details in the form design. The value perception comes from the symbol, association, and emotion. Designers should abstract the appearance of the product to lines and shapes. Choosing the lines that meet consumers' demand (concluded from Contextual Difference and Function Analysis above) will add value perception to the product. For example, children's toys are usually designed using curved lines rather than zigzag or straight lines.

(2) Material and Texture

Different materials will have different value in various products. The most important thing designers need to consider is the material selection, and factors that influence the selection. The texture is mainly influenced by the finish, or sometimes influenced each other, and a proper selection of material will add value to the visual

texture. The Material and Texture Selection (Figure 18) is a set of guidelines that help designers choose higher or lower value material and texture based on the target user group.

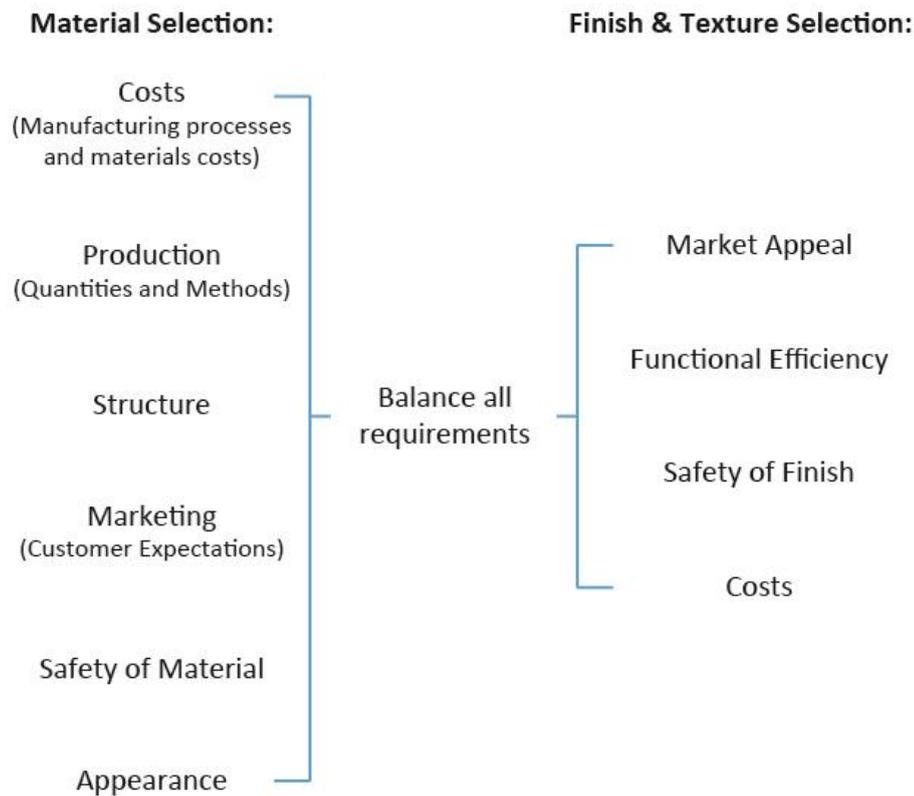


Figure 17. Selection of Material and Texture

Following the guidelines in Figure 17, the selection of material and texture is divided to two parts, material selection and finish and texture selection. The first part includes these steps:

- A. **Costs:** Designers should consider and research the costs in the manufacturing processes and the costs of materials on a macro level.
- B. **Production:** Designers should get the basic information about production quantities and methods, and select proper materials that fit within the needs of production.
- C. **Structure:** Designers should figure out the product structure by sketching,

CAD, and test models. In this process, they will find whether some materials are inappropriate for the structure.

- D. Marketing: This step is based on the Target User Group Analysis. Designers should control the customer expectations of the product and select the appropriate materials and textures.
- E. Safety: Designers can consider material safety with safety in human factors.
- F. Appearance: Designers need balance between appearance and all the factors above in material and texture selection. The visible surface of product components will influence the value perception of consumers.

The second part is Finishes Selection:

- A. Market Appeal: The visible quality of the product is often influenced by the finishes. The higher finish standard will provide better performance and higher perceived value of the product.
- B. Functional Efficiency: Designers should consider the finishes depending on the function and the texture demands of the product.
- C. Safety: Finishes will influence the safety performance of the product as well. A too smooth and reflective surface may cause hazard in usage for most products. This step will be considered by designers combined with the safety analysis in human factors.
- D. Costs: Like the costs in material and texture selection, designers need to figure out the general costs of finishes in manufacturing processes.

After analyzing the material, textural, and finishes selection, designers should balance all the requirements to decide the most appropriate materials, and improve their

design to create a higher perceived value product. Please note that the texture cannot be considered separately, and it should be decided by material and finish together.

(3) Color

The color selection is mainly decided based on the target user group and the functions of the product. Designers should consider color selection with the perception, emotion, or association of colors, to develop a high perceived value product. Table 10 gives the psychological effects of the most common colors, which is concluded from the study of Niku (2009), Beasley and Palmer (1986), and Graves (1951).

For example, due to the great power of attention of red color, most power switches will use red to draw attention. If the power switch uses yellow color, it is hard for consumers to understand its an on/off switch. This will reduce the value of the product. Thus, designers should apply color selection to design according to the

functions and user demands of the product and the components of the product.

Color	Characteristics	Emotion	Association
Red	Greatest power of attention, most popular, positive, aggressive, and exciting	Stimulating, positive, aggressive	Fire, danger, blood, stop, hot, left
Yellow	Most luminous, least popular (particularly the darker shades)	Cheerful, warm, outgoing, vitality also envy and cowardice	Sun, caution
Green	Neutral, passive, most restful of colors	Restful, cool, serene	Nature, vegetation, go, spring, hope, renewal also jealousy
Blue	Cool, serene, passive, and tranquil	Opposite of red, cool, subduing, peace, calm, serenity also sadness and grief	Sky, water
Purple	Stately, rich, pompous, and impressive	Solemnity, rank and authority also depression and rage	Royalty, mourning
White	Positive and stimulating, luminous, airy, light, and delicate	Neutral to positive effects, purity	Snow, marriage, purity, (death in China)
Gray	Ideal background for most colors, mellow, pleasing	Neutral, contemplation	Overcast
Black	Subdued, depressing, solemn, and profound		Death, darkness

Table 10. Selection of Color

4. Human Factors

This section will give guidelines on how to apply Human Factors methods to guidelines that control the value perception, and list the data sources for designers to collect all the information they need, especially the anthropometric data. The guidelines will help designers to figure out what needs to be considered regarding human factors in the design process.

(1) Psychological Characteristics

Learning Curves, Boredom, Mental Fatigue, and Attention: When the product is too simple, as operation time increases, consumers' skills will increase (Learning Curves), and they will feel less challenged and bored (Boredom). On the contrary, when the product is too complex, as operation time increases, consumers will learn how to use the product (Learning Curves) but feel tired (Mental Fatigue) and careless (Attention). Figure 18 shows the relationship between time and all these characteristics, which is based on the typical Learning Curve.

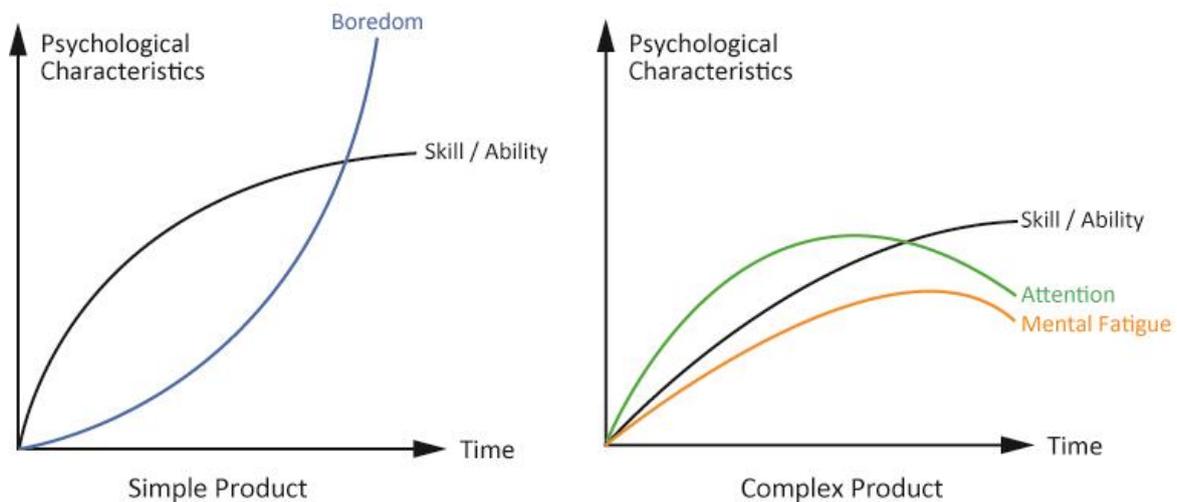


Figure 18. The Relationship between Time and Psychological Characteristics

The application of a learning curve (Figure 18) can be various depending on different details in product. For example, the red color button will be easier to draw attention, which is usually used on power button. If the power button is a grey color and same with the whole body of the product, with time increase, the careless and metal fatigue may cause misuse in the power control and bring dangers. In another example, the visual functions of product can also be evaluate and improve by psychological factors. In other words, appropriate placement or a visual icon will remind consumers how to use the functions, which is the attention in learning curve.

(2) Physiological Characteristics

Anthropometric Design Strategies: In addition to considering the psychological factors, designers need to decide the appropriate dimension of the product and the range of dimensions so that consumers can operate the product comfortably and safely. The anthropometric design strategies will help designers figure out how to apply the proper data into their design depending on the target user group. How to collect the anthropometric data will be discussed in section of Data Sources later. Drawing from the theory of Burgess (1989):

- Designing for the Median: This means the average size design. A product that costs too much to design if extremely small to the extremely large will derive benefit from using this strategy.
- Designing for Extremes: That is commonly applied for the product that need to consider the largest or the smallest dimension of human, such as the height of a door.
- An Adjustability Strategy: The product with this strategy will provide an adjustable range of sizes, and should be used whenever possible, such as seat height or helmet size.
- A Full-Range Strategy: This strategy is useful for products that every person needs to use, and will cover the complete range of body size, such as an escape device, an emergency hammer, and an escape hatch.

All the strategies above is based on the analysis of the Target User Group, and designers need to apply them depending on the consumer group demands.

(3) Product Safety

Designers need to give first priority to product safety in the designing process. The most common hazards in the operations of the product, and how to eliminate them are listed below, which is based on the research of Niku (2009):

- A. Hazard Recognition: Kinematic hazards, energy hazards, electrical hazards, chemical hazards, material hazards, environmental hazards, misuse and abuse hazards.
- B. Hazard Elimination: Human factors considerations, design changes, safety devices, guards and switches, warnings and instructions.

(4) Data Sources

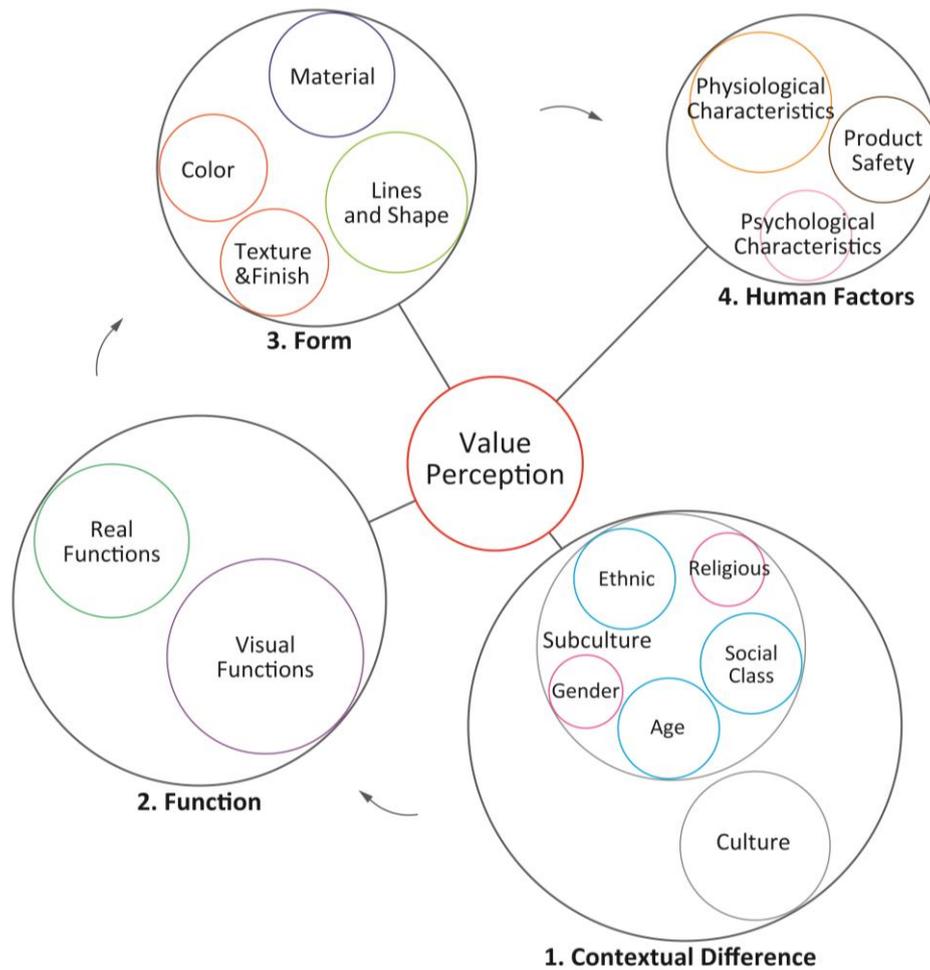
Designers need to collect data by themselves in many cases. There are common sources of human factor data, and designers should analyze them according to their demand. According to Tillman and Tillman (1991), the information can be collected from these paths:

- Professional Fields: Performance tests, physical measurements of humans, task observations, and surveys.
- Valid Specific Information Paths: Research Reports, Human Factors Design Handbooks, Human Factors Design Standards.

Overall, in Human Factors, designers should collect data, consider both the psychological and physiological characteristics, and analyze possible hazards in consumers' operation. After doing the analysis, designers can figure out how to design a product that is higher perceived value or lower perceived value.

3.2 Relationship between All Factors and Design Process

Based on the analysis of all the possible factors that influence consumers' value perception above, this section concludes a relationship figure that includes all the factors, ranked by their influence for the value perception (Figure 19). This relationship will be the fundamental framework for the formation and development of the guidelines.



Factors	Purpose	Design Process
Contextual Difference	Target User Group	Research
Function	Function Criteria	Research & Sketch
Form	Visual Performance	Sketch & CAD
Human Factors	Evaluation and Improve	CAD & Model

Figure 19. Relationship between Factors

The four major parts are Contextual Difference, Function, Form, and Human Factors, and each part includes several detailed factors. The central part is consumers' Value Perception. The distance (length of lines) from Value Perception and the size of the circle imply the order of importance for the influence. For instance, the nearest major part is Contextual Difference, and it includes Culture and Subculture. The Subculture circle is bigger than the Culture circle, which indicates the Subculture has more influence on Value Perception than Culture. In the Subculture circle, Ethnic, Social Class, and Age are the same blue color, Religious and Gender are the same pink color. The three blue circles are bigger than the two pink circles, which means Ethnic, Social Class, and Age plays a greater effect on Value Perception than Religion and Gender.

In addition, the number and arrow indicate the thinking order of designers in their design process. The first step, Contextual Difference is used for confirming the target consumer group. The second step, Function is for figuring out “what the product should be”, and summarize a function criteria. The third step, Form, should determine the appearance of the product, and the purpose of the last step, Human Factors, is ensuring the performance of the product is good to interact with people.

Therefore, the Relationship between Factors is a visible tool to show all the factors' importance of the consumers' value perception, and it will be very helpful for the designers to comprehend how to apply the design guidelines into improving their products.

3.3 Conclusion: Design Guidelines for Product that Influence Consumers' Value Perception

All the Tables and Figures provided in this chapter are complete design guidelines, which should follow the relationship between all the factors in Figure 19.

Connecting with design process:

- Contextual Difference is the primary confirmation of target user group.
- Function is the next analysis about function criteria. Concepts in sketches should be developed in this section.
- Form is the improvement of visual appearance. Sketches or CAD renderings should be further developed.
- Human Factors is an evaluation of the previous concept and test the overall performance of the product. Prototype should be finished.

After following the guidelines (the design process as well), designers will make a final physical model to display the complete product. Through this design process, designers will figure out how to control the consumers' value perception of the product.

CHAPTER 4

DESIGN APPLICATION

4.1 Introduction

This section will focus on two aspects. One is applying the design guidelines to evaluate a current low perceived value product. Another one is redesigning this product to one of high perceived value by using the design guidelines. The process will prove the practicability of design guidelines and help designers to further figure out how to apply the guidelines to their design processes.

4.2 Low Value Case Study: QHE Bluetooth Speaker

Through applying the design guidelines in chapter 3, a low value product will be analyzed from designers' viewpoint. Shown in Figure 20, the product is QHE Bluetooth Speaker (from QHE company), which is portable both indoors and outdoors.



Figure 20. QHE Bluetooth Speaker (QHE, n.d.)

4.2.1 Contextual Difference Evaluation:

Following guidelines of contextual difference, combining the Target User Group Analysis (Table 8) in Chapter 3, this speaker will be analyzed in Table 11. In many situations, designers will only get a general direction of target user groups, which usually comes from the marketing department in a company. The contextual difference research will help designers to narrow down the target consumers and provide specific analysis.

Contextual Difference: Target User Group Analysis						
Subculture	1	Ethnicity	Nation : China			
			Race :Majority Han			
		Social Class	Low Class			
			Middle Class			
			High Class			
		Age	Children under Thirteen			
			Teenage Group			
	Young Adults					
	Senior Citizens					
	Special Age Group	Infant				
Elder						
2	Religion	Is the product designed for a certain religious?	No	Yes	What's the religious	
	Gender	Is the product designed only for female or male?	No	Yes	Female	Male
Culture	3	Core Value	Does the product designed consider a core value? What's it? No.			

Table 11. Target User Group Analysis for QHE Speaker

Subculture: According to the introduction in online store, the QHE Bluetooth speaker is designed for most Chinese people in China. There are 56 races in Chinese people. Due to the majority of them being Han Chinese, the line 2 in Table 11 should be majority Han. Considering the price of this speaker, only 7 dollars, it is mainly focused on low class people. The age group includes from teenager to all the adult; and the speaker is not aimed at any religious and gender.

Culture: The core value designers should consider in speaker design can include many aspects. For example, if the shape or outside view of the speaker looks like a coffin

in China, consumers will not purchase it because Chinese people believe this kind of shape will bring death. For another example, the most popular activity in China recently is Public Square Dance, which is an exercise dance of group of people. If the speaker is designed for Square Dance, it is a design combining with the core value of China. According to the introduction, the QHE Bluetooth speaker is not designed with a certain core value.

Therefore, after evaluation of the guidelines, this target user group of this product is: the majority Han in China market, low class, and age from 13 to adults. This result of the analysis shows that the product has low value perception to fit this target user group.

4.2.2 Function Evaluation

Description of product (Figure 21) shows the available functions of QHE Bluetooth Speaker, which include:



Figure 21. Description of product (QHE, n.d.)

- Powerful Sound
- 6 hours playtime
- Connectivity: wireless Bluetooth 4.0, TF card support, AUX support, USB connection.

- Built-in microphone supports any smart device with Bluetooth function
- Control: Volume control, play & power switch.

Following the guidelines and Function Analysis Chart (Figure 17), the chart in Figure 22 shows the comparison of available functions and consumer expected functions. If functions meet consumers' expectations, it will add to the perceived value. On the contrary, functions that cannot fit expectations will bring lower value perception.

Consumer's Expectations (Assign Priorities) (Target User Group Research)	Available Functions
Good sound quality	
Long playtime	Only 6 hours playtime
Easy to connect to any device	Wireless Bluetooth 4.0, TF card support, AUX & USB connection
Answer calls	Built-in microphone supports any smart device with Bluetooth function
Easy to control	Volume & Play control
Durable: No worry to drop it	
Long battery lifetime	
Loud	Powerful Sound
Waterproof	

Figure 22. Comparison of available and expected functions

Shown in Figure 22, this QHE Bluetooth speaker only has five functions. The best expectation of consumers, good sound quality, cannot be satisfied by this product. It can only meet about half of the expectations; and most functions will not cost too much. Thus, from the aspect of functions, the QHE Bluetooth speaker has low value perception.

4.2.3 Form Evaluation

In the aspect of form, the perceived value of this speaker will be evaluated by lines and shape, material and texture, and color.



Figure 23. The form of QHE Bluetooth speaker (QHE, n.d.)

(1) Lines and Shape:

Shown in Figure 23, this product uses straight lines (horizontal and vertical lines) with two filleted edges. The shape and overall body is like a cuboid. Following Table 9, Selection of Lines, in the design guidelines, the perception of straight lines is rigidity, stiff, harsh, and hard. The perception of curve lines is a feeling of gentle and loose. Considering the cuboid body, the QHE Bluetooth speaker will make consumers feel hard and rough in both entire body and details.

(2) Material and Texture:

Depending on the description of this product in online store, the main material is ABS.

Following the guidelines of selection of material & texture (Figure18) and selection of finish, the value evaluation in this part is shown in Figure 24:

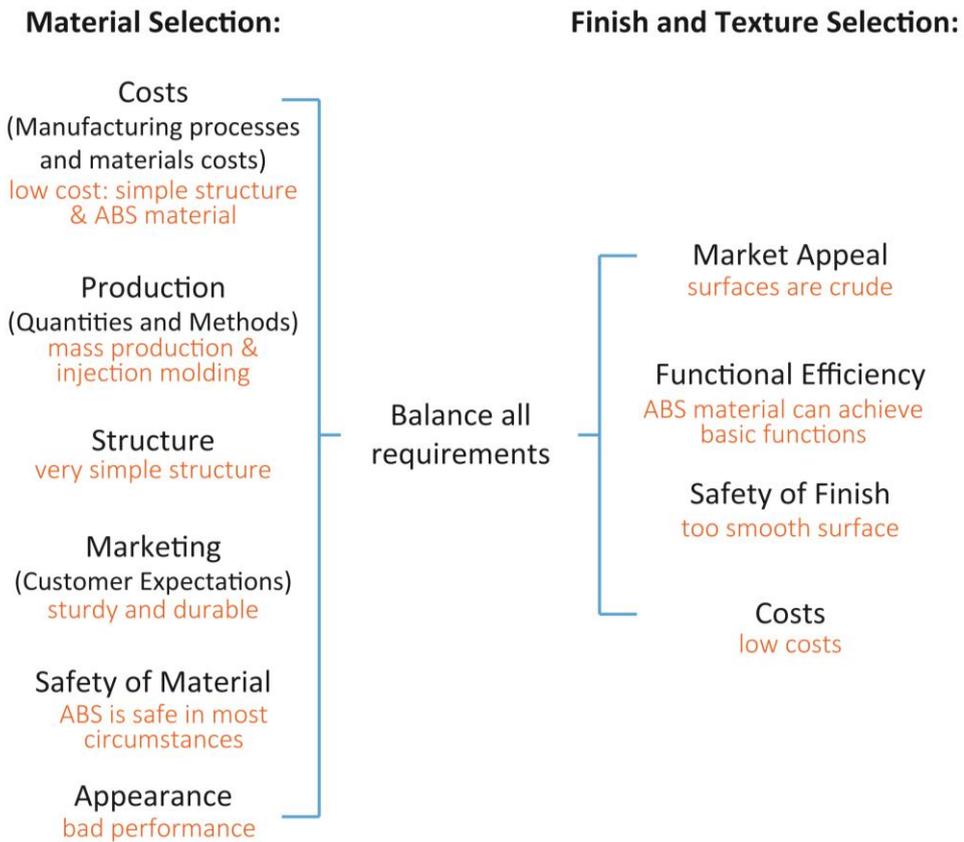


Figure 24. Material Evaluation

- This speaker main material is ABS; manufacturing method is injection molding. Considering the available functions, materials and simple structure, this speaker will be low cost.
- The most important consumer expectations about material are sturdy and durable, which are decided by the target user group. ABS material can achieve basic functions.
- From details of this product (Figure 23), connection ports (include power,

USB, AUX, and TF port) are too fragile and rough. It will be easy to break or shake them in operation, so it is not durable. Besides, the too smooth plastic surface may bring a danger of slipping out of hands.

- The appearance of materials and textures will influence the aesthetic performance of the product. The material and finish of whole body and details are crude, so it has bad performance in appeal.

In conclusion, the QHE Bluetooth speaker has low value perception in material and texture.

(3) Color:

The color evaluation will be from the aspect of psychological effects of different colors, and determine the value perception of colors in this product.

Using the guidelines of colors and the Selection of Color (Table 10), color evaluation will be:



Figure 25. Colorful indication light (QHE, n.d.)

- This speaker use white as body color, and a colorful indication light (Figure 23 and Figure 25). Depending on Table 10, white as background

color shows a feeling of purity and luminous. Using white on body shell is a little bright. The biggest problem is all the buttons and ports cannot be distinguished in this whole white color. Additionally, the colorful indication volume light is effective in drawing attention, especially on the white background.

- The color in detail parts is not distinctive. Shown in Figure 25, the forward and backward button is white as well, so it is hard to notice. The USB, AUX, TF card, and power port using white (Figure 23), which is same with the background color of body. Thus, the color of these details cannot draw attention.
- Most speaker grill part is black color, because it is easy to be dirty. However, this product uses white in speaker grill (Figure 25).

Therefore, the form evaluation, which followed the design guidelines, including lines and shape, material and texture, and colors, shows the low value perception of this product.

4.2.4 Human Factors Evaluation

Human factors evaluation will follow the design guidelines and analyze the QHE Bluetooth speaker from three aspects, which include psychological characteristics, physiological characteristics, and product safety.

(1) Psychological Characteristics

The psychological characteristics for the QHE speaker means whether consumers can understand how to use the product when they look at it. The

QHE speaker uses a colorful LED light on volume control to draw attention, which is a good performance in psychological influence (Figure 25). People will easily understand how to control the previous and next track as well as, the volume. However, this speaker looks like it has no power button. Consumers will feel confused how to power it on/off. Actually, instructions are included only in the product description, the power on/off is to hold the next track button for three second. Thus, in power control, QHE shows bad performance of psychological factor.

(2) Physiological Characteristics

Except for psychological aspects, a product with appropriate dimension (or the range of dimension), which for both the whole body and all detail parts, will add value perception for consumers.

- Depending on physiological strategies in design guidelines, the QHE Bluetooth speaker fits on the strategy of Designing for the Median, which means average size design because the product will cost too much to design from extremely small to extremely large of human body. In other words, the selection of anthropometric data in this speaker just needs to meet the majority of target users.
- Based on the Median Strategy, for example (Figure 23), the power port, USB port, and power switch place are so close to each other, so consumers will feel the space is too narrow to operate it. Obviously, designers did not consider the hand size of human and the dimension of operation range. In addition to ports' location, backward and forward

buttons (Figure 25) are very small and too close to the volume control part, which may bring mistakes in operation. Thus, this speaker can be evaluate as low perceived value in anthropometrics.

(3) Product Safety

Actually, this part should be consider together with the previous two aspects, because inappropriate selection of anthropometric data may bring danger. Following the guidelines of all the possible hazard need to be considered, this speaker may bring these hazards:

- Electrical Hazards: Narrow placement of all the ports.
- Misuse and Abuse: Includes the unexpected uses of the product, and possible mistakes that users may make. If consumers cannot find the power button, they may use the speaker power on/off by connecting or disconnecting the power line.

Aiming at these two possible hazards, designers should consider how to eliminate and avoid them. Following the evaluation in material and physiological characteristics, the nondurable structure of the ports and buttons cannot eliminate these hazards. Thus, from the aspect of product safety, the speaker has low value perception.

In conclusion, after evaluating the QHE Bluetooth Speaker by using the characteristics of the design guidelines, it is a product with low value perception. Considering the target user group (low class people), this product can only meet their basic demands.

Not all products should be designed to high value perception. This case study will give a reference for designers in designing a low-end product, and help them figure out how to apply the design guidelines. The next application will redesign a high perceived value speaker but keep all the available functions of the QHE Bluetooth speaker to further prove the design guidelines.

4.3 Redesign Application: the high value Bluetooth Speaker

Based on the evaluation of QHE Bluetooth speaker, this section will provide a specific process to redesign the speaker by following the design guidelines.

4.3.1 Concept Development: From Sketches to CAD

This section include contextual difference, function, and form in the design guidelines. It will apply the design process to the guidelines. The contextual difference is to conclude the target user group. The purpose of function analysis is to summarize the function criteria. The part of form is to improve the product by evaluate the concept draw from the previous two steps.

The process of this section should be several sketches and showing the concept development. The result of this section should be some CAD renderings to reflect the visual performance of the product development.

4.3.1.1 Contextual Difference: Target User Group

The QHE speaker focuses on this target user group: the majority Han in China, low class, and age from 13 to adults (Table 11). The redesigned speaker with high value

keeps the same ethnicity, social class and age group, which are subcultures. In addition, the redesigned speaker will add core value, which is culture. As mentioned before, the core value that fits for the target consumer groups will add value perception.

The majority Han in China actually means most Chinese people in China, because the Han race includes the most population in all 56 races (all Chinese people) in China. Based on this ethnicity group, the redesigned speaker chooses two core value (Culture part in Contextual Different). The first core value is designed with Chinese cultural style. The second core value is to connect the design with Public Square Dance, which is the most popular group activity in China recently.

(1) Chinese Culture Style: Yunlei Totem

Yunlei is a decorative totem on bronze ware in Shang and Zhou dynasties in old China (Figure 26). Mentioned by Chen (2003), Yunlei means thunder and cloud, due to this totem combines the abstract shape of the thunder and cloud; It is like squares with round corners. Yunlei totem reflects people's respect and fear of natural power. This decorative totem shows the wish of good weather, especially for farmers in old China (p. 5-7).



Figure 26. Yunlei Totem (Yunlei, 2012)

The high value redesigned speaker will apply Yunlei totem to reflect the Chinese culture style, especially in visual implication. This totem in design will add perceived value in attracting the target user group who likes Chinese culture.

(2) Public Square Dance

Public square dance is almost the most popular group activity that is suitable for people from teenager to elderly in China (Figure 27). It is an exercise dance performed to music in squares, plazas, or parks; and easy to participate for both men and women, from children to elderly. In addition, they need a speaker to play music when they dancing. The redesigned speaker will be based on the need of these people, because they are part of the target user group. Furthermore, most music in public square dances are Chinese music or Chinese popular songs. The people who like public square dances will find it more acceptable if it uses the Chinese culture style mentioned above.



Figure 27. Public Square Dance (Public Square Dance, 2015)

Therefore, in order to add perceived value to the speaker, the target user group will be based on majority Han in China, low class, age from 13 to adult, and further considering the consumers who like Chinese culture and public square dance. The Target user group analysis will be shown in Table 12.

Contextual Difference: Target User Group Analysis						
Subculture	1	Ethnicity	Nation : China			
			Race :Majority Han			
		Social Class	Low Class			
			Middle Class			
			High Class			
		Age	Children under Thirteen			
			Teenage Group			
	Young Adults					
	Senior Citizens					
	Sepcial Age Group	Infant				
Elder						
2	Religion	Is the product designed for a certain religious?	No	Yes	What's the religious	
	Gender	Is the product designed only for female or male?	No	Yes	Female	Male
Culture	3	Core Value	Does the product designed consider a core value? What's it? Yes. Chinese culture style and Public Square Dance.			

Table 12. Target User Group Analysis for Redesigned Speaker

The purpose of adding these two core value, Chinese culture style and public square dance in the redesigned speaker is to show the cultural influence in the contextual difference in the design guidelines. However, in the general design process, designers need to use Table 12 to narrow down the information from marketing department or other consumer research groups, and finally conclude a specific target group themselves by applying this form. Because sometimes designers only get limit information from a company in target consumers analysis.

Depending on the contextual difference, the first step in redesign is to draw some sketches and try to combine the Chinese Yunlei totem into the speaker, shown in Figure 28. After discussing the functions and form, the primary concept will be improved.

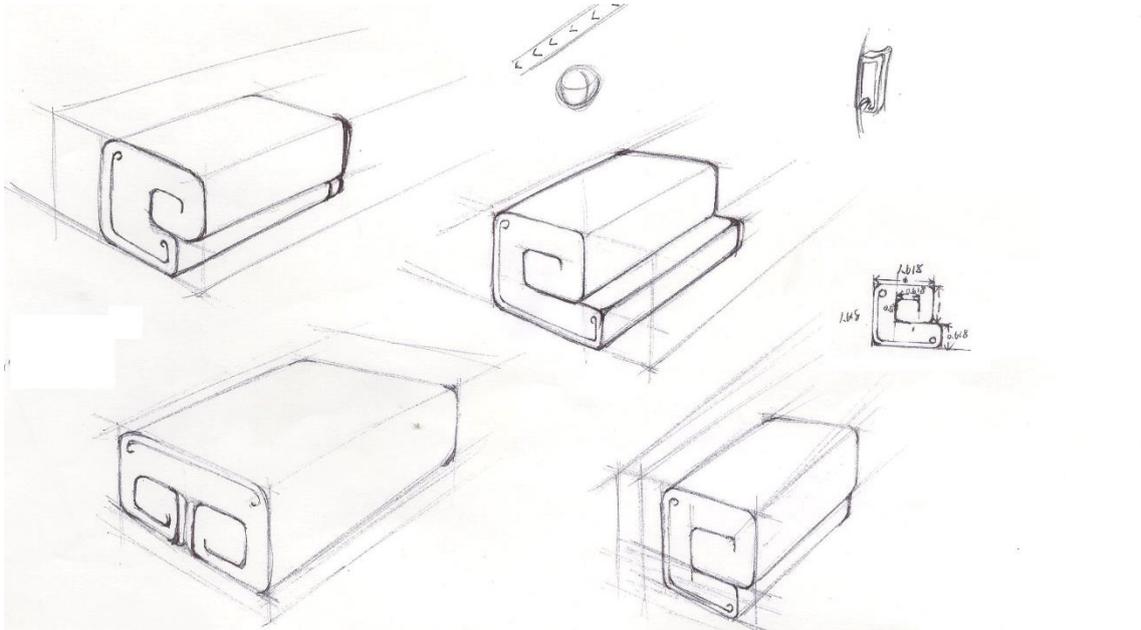


Figure 28. Chinese Culture Style Sketches

4.3.1.2 Function Redesign

In the design process of a new product, designers should determine the function criteria depending on the target user group in contextual difference analysis. The functions that influence value perception include real functions and visual functions. For the majority of products, more real functions will add value or perceived value to the product. In other words, it is not hard to add value perception by adding more real functions or improving functions. However, complex functions will add production cost at the same time. Based on same low social class of target users, the redesigned speaker will add perceived value by controlling the visual functions.

Based on the available functions of QHE Bluetooth speaker (Figure 21 and Figure 22), and following the function guidelines in Figure 17, the Function Analysis

Chart for the redesigned speaker is shown in Figure 29:

List Consumer's Expectations and Assign Priorities (Target User Group Research)						Technical Difficulty
	Shape	Size	Weight	Technical Factor	Material	Processing Costs
	1	1	0	3	2	
	2	1	2	3	3	
Good sound quality	1	1	0	3	0	
Easy to connect to any device	0	0	0	2	0	
Powerful sound	0	1	0	2	0	
Long playtime	0	0	0	2	0	
Easy to control	2	1	0	2	0	
Answering calls	0	0	0	2	0	
Waterproof	0	0	0	2	3	
...						

3 very strong impact
 2 strong impact
 1 weak impact
 0 no impact

Figure 29. Function Analysis Chart for redesigned speaker

As shown in Figure 29, in consumers' expectations, good sound quality relies on high technical support to a large extent, and will bring high processing costs and technical difficulty. Considering the purchasing power of low class consumers, the redesigned speaker can only achieve sound quality as good as possible rather than ensuring excellent sound quality. The function of waterproof will not be included in the function criteria due to its high processing costs and technical difficulty. In addition, waterproof is not so necessary in expectations of target consumers. Other five expectations in Figure 29, easy to connect to any device, powerful sound, long playtime, easy to control, and answering calls, are basic and necessary functions to a higher perceived value speaker.

Therefore, the function criteria (assign priorities) of redesigned speaker should

be:

- Easy to connect to any device: Bluetooth 4.0, TF card support, AUX and USB connection
- Powerful Sound: Loud enough especially in outdoors
- Long playtime: As long as possible
- Easy to control: Volume, play, and Bluetooth pairing
- Answering calls with built-in microphone

Following function criteria, the concept is improved in Figure 29 and Figure 30.

The power button is on the side of the speaker. In the middle part, there are Bluetooth pair button, microphone on/off, previous and next track, and volume control. The Yunlei totem is further improved in this section.

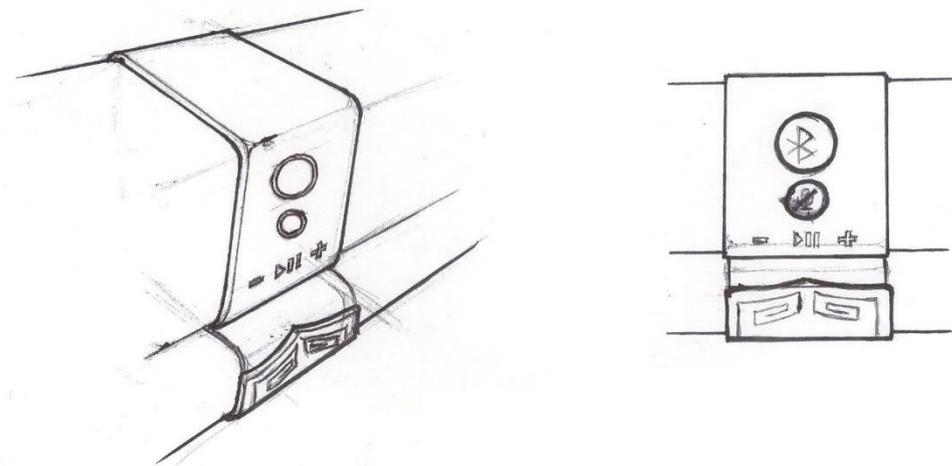


Figure 30. Concepts with functions

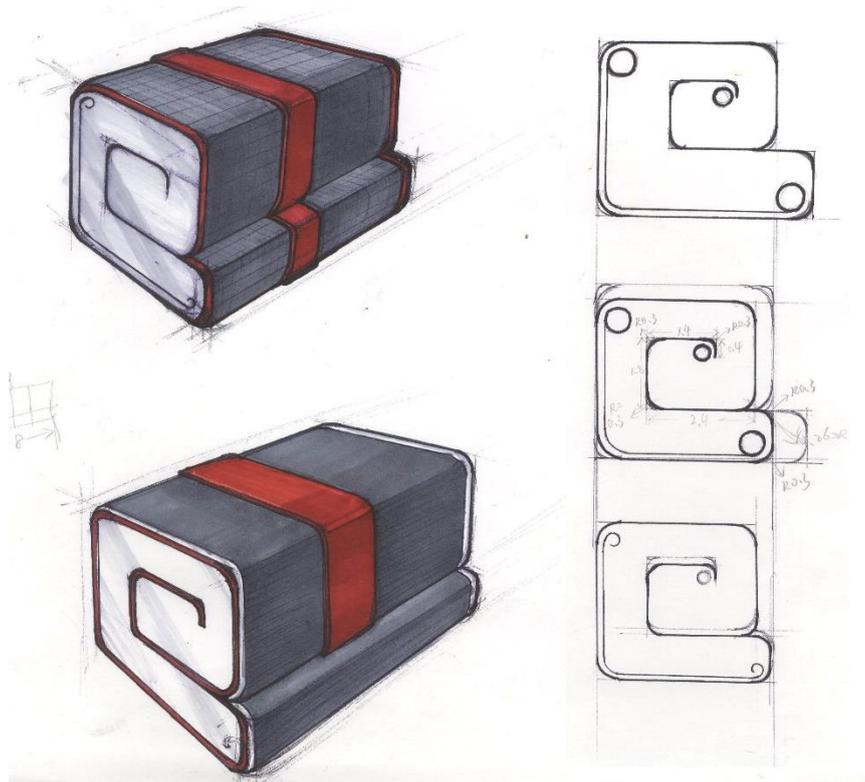


Figure 31. Concepts with Yunlei totem

4.3.1.3 Form Redesign

Depending on the function criteria, the whole body structure can be determined, as mentioned in concept sketches above. The form guidelines are applied to evaluate and improve the appearance and exterior style of the speaker. As shown in Figure 32:

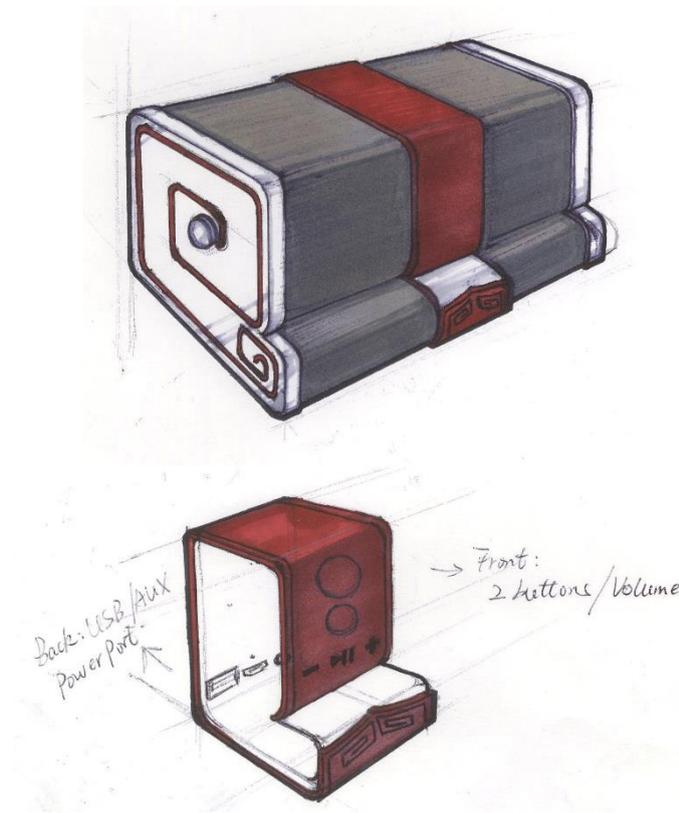


Figure 32. Form of Redesigned Speaker

(1) Lines and Shape:

There are many straight lines in QHE Bluetooth speaker, so it has a feeling of hard and rough. To improve the lines, the redesigned speaker will use more curves and round corners to make it have a sense of gentle. The red curve lines reflect Yunlei totem, and the body of speaker will fit this totem as well to make it achieve Chinese cultural style. The middle red part shows a small Yunlei totem in the front view, and most control buttons will be placed on this middle part. The shape of round buttons are easier to help consumers to understand the control method.

(2) Material and Texture:

Considering the target user group, the redesigned speaker will use ABS as well because ABS plastic is cheaper, easier to produce, and can be good

performance in appearance. After balancing the material and finish selection in Figure 24, the redesigned speaker will use ABS and fabric materials.

As shown in Figure 32, the high perceived value speaker will use ABS on the two silver sides and middle red parts. The Yunlei totem decoration curves are ABS as well. The grey parts are fabric and cover the speaker grill. The production method will be injection molding, which is lower cost. The fabric parts makes the speaker will not too smooth to hold, and the ABS will perform better in production, which will make the surface are clean. The reason to choose ABS and fabric is to lower the cost and keep a good performance in appearance and safety at the same time.

(3) Color:

There are three colors in the redesigned speaker, red, grey, and silver. The fabric color can be grey or dark red to keep same style with the whole body. The purpose of using red color is to reflect the Chinese culture style and make the Yunlei totem more distinct. The silver color is to try to make ABS looks like aluminum, which will add the perceived value.

4.3.1.4 CAD and Conclusion

After the analysis about all the target user group, function criteria, and form evaluation mentioned above, the concept will be developed from sketches to CAD rendering. The purpose of sketches is primary research about how to add value perception of the speaker; the CAD model and rendering is to further develop the concept and test the structure and exterior performance. As shown in Figure 33 and 34:

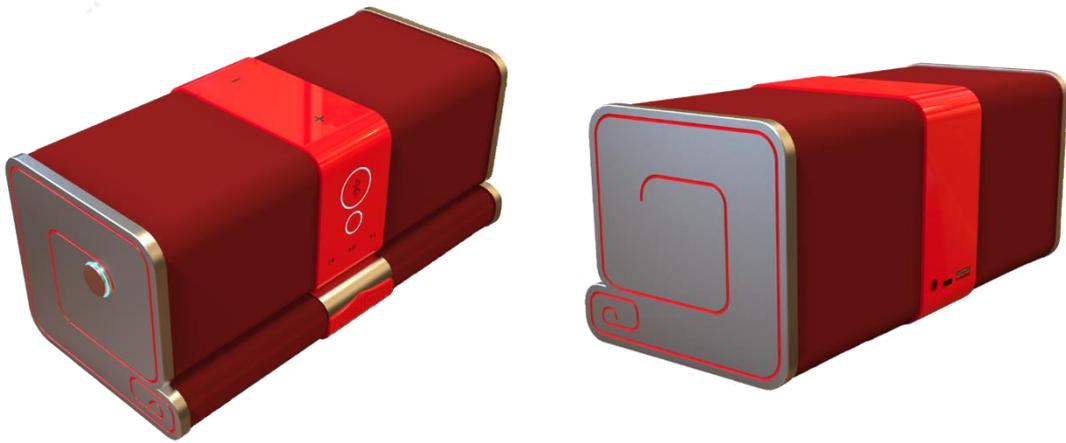


Figure 33. CAD Rendering of Redesigned Speaker

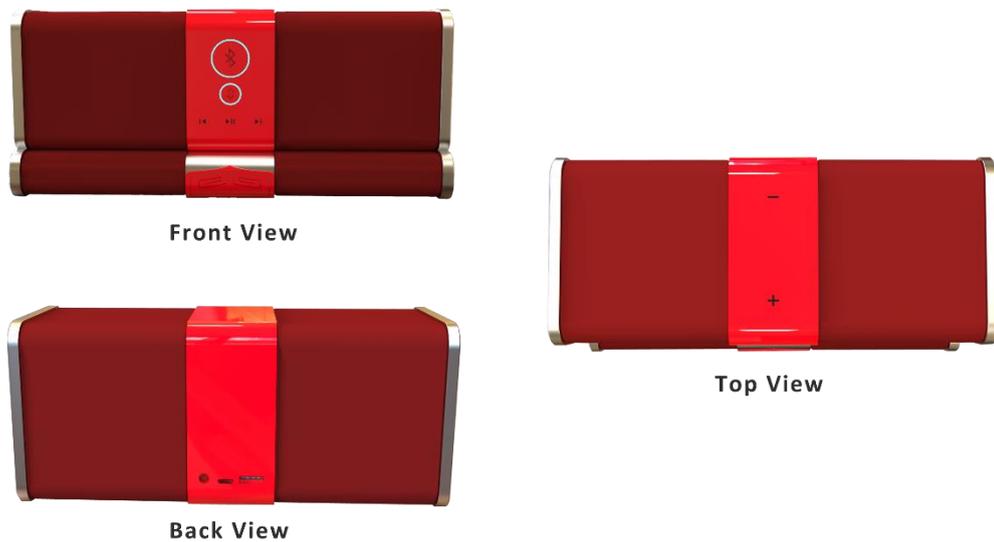


Figure 34. CAD Rendering of 3 Views

- The Yunlei totem on the side and middle, and the red color reflects the Chinese cultural style.
- The dark red part is fabric to cover speaker grill, and the other parts used ABS plastic materials. The two silver parts shows a texture of aluminum with ABS.
- The power button is on the side with a light blue indication LED light. Other buttons, including Bluetooth pairing, microphone on/off, previous and next

track, play/pause control, and volume control, are placed on the middle red part. The pairing and microphone button are the two main controls, which is distinct with a light blue circle. The volume control is on the top of the speaker, which is easy to use.

- On the back of the middle red part, there are AUX input, power port, and USB port.

4.3.2 Concept Evaluation and Final Model: Human Factors

After the concept develop mentioned above, designers should further evaluate whether the product is good to use by applying human factors in design guidelines. Finally, designers will make a physical model to test human factors.

4.3.2.1 Human Factors: Evaluation Concept

Human factors include: Psychological Characteristics, Physiological Characteristics, and Product Safety.

(1) Psychological Characteristics

Due to the bad performance of the power control button on the QHE speaker, the redesigned speaker improves it to a distinct power button with light blue LED light. In addition, all buttons are easily understood how to use for consumers. The Bluetooth pair button uses a Bluetooth icon, and the microphone on/off uses a mic icon (Figure 35). The volume control shows by “+” and “-”, which is very easy to figure out the function as well.



Figure 35. Control Buttons

(2) Physiological Characteristics

Depending on analysis of the QHE Bluetooth speaker, the redesigned speaker should keep the same strategy, Designing for the Median. In addition, Based on the Median Strategy, the dimension of redesigned speaker is 8*3.5*3.8 inches, which is easy to hold and portable for average size of humans.



Figure 36. Back View

As shown in Figure 36, the redesigned speaker changes the arrangement of the power port, USB, and AUX input. All the ports are placed on the back of

the speaker, and keep a certain distance between each other. The central red part is 2 inches wide, which is convenient for the finger of humans to touch to all the buttons and ports (Figure 35 and 36).

(3) Product Safety

The QHE speaker may bring some hazards, such as electrical hazard (the narrow location of all the ports), and misuse hazard (cannot find the power button). To eliminate these hazards, the redesigned speaker shows easy-to-understand buttons, and add the distance between ports.

In addition, round corners of the outside shell will avoid scratch danger for humans; Fabric materials (mentioned in Form section) will add force of friction, which makes the speaker easier to hold than one with a smooth surface.

Therefore, in human factors evaluation, the redesigned speaker has high perceived value in operation. The further test will be achieved in the final physical model.

4.3.2.2 Final Model

Depending on the theoretical analysis in design guidelines, the final physical model of redesigned high perceived value speaker will be further tested, especially for human factors (Figure 36).



Figure 37. Final Model

4.4 Conclusion

The design guidelines for product that influence consumers' value perception is divided to four sections: Contextual Difference, Function, Form, and Human Factors. The sequence of all these factors shows a design process as well. From Contextual Difference, designers should narrow down target user group, and draw a primary concept by sketches. The Function guidelines direct designers to conclude a function criteria and lays the foundation for the form of product in next section; designers can use sketches or CAD to develop the further concept. In Form section, designers will improve the product and get an overall concept based on the previous analysis, then CAD renderings

will be finished. The Human Factors helps designers to further test performance of the product, a prototype shows visual perceptions. After all of these four sections, designers should make a final model, which is an improvement of the prototype, to show the final performance of the product.

All the possible factors that influence consumers' value perception are included in all the four sections mentioned above. Following the design guidelines, designers should create a product that meets their requirements in the aspect of value perception. A lower perceived value product can be redesigned to a higher perceived value one, and a new product can be achieved as well. In new product development, designers should apply the guidelines on the basic of the value requirement of their companies or their clients. In other words, the design guidelines will help designers to design a higher or lower perceived value product depending on their needs.

4.5 Recommendations and Further Study

The design guidelines is a foundation in analyzing the relationship between design and consumers' value perception, and provides study direction and the first step in this area. The guidelines can be used in the majority of industrial products. In the future study, the guidelines should be further developed by collecting more data of consumers' behavior and psychology. Based on the data from questionnaire surveys and interviews, the design guidelines may be further improved.

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