

CULTURAL DIFFERENCES IN PRODUCT DESIGN BETWEEN THE UK AND CHINA

FANGYAN TANG, BA

Thesis submitted to the University of Nottingham for the degree of Doctor of Philosophy

May 2016

ABSTRACT

Design is one of the significant intellectual activities of human beings and is therefore inevitably influenced by culture, which as Hofstede describes, influences 'all aspects of human life'. Product design, which emerged in the middle of the last century and is developing under the background of globalization, is a relatively young domain in the design area and also unavoidably a topic of interest in the field of culture study. This thesis brings forth a perspective on the need for an examination of product design in a cross-cultural context. Product design in this research was decomposed into two main components: the design outcome and design process.

Two empirical studies were conducted to investigate the cultural differences from the perspective of design outcome. The technique of repertory grid analysis, applied in interviews with participants from the UK and China, found distinctive attributes of designs created by student designers. The designs from the UK students tended to have rounded shapes, simple structures, fewer functions and less creativity; whereas the designs from the Chinese student designers tended to have squarer shapes, more complex structures, more functions and greater creativity. Notable differences were also found in the criteria of design evaluation: people from the UK and China had different emphases on aesthetics, ergonomics and creativity. The differences in design evaluation were validated with a larger sample size using an online survey.

Differences in design process were also revealed by two empirical studies that investigated the design activities of designers from the two cultures. A study using a post-hoc reflective method was conducted to analyse submissions from design students, supplemented with an ethnographic observation of daily design activities in a studio. Differences were found in the patterns of design process as well as in the design cognitions revealed through the design representations. UK students were found to sketch more and used sketching as a means of recording, presenting and generating ideas, whereas Chinese students tended to sketch less

and used sketching more as a tool for recording and presenting ideas. Chinese students also showed an obvious tendency towards considering a design task in a relational-contextual way, i.e. they tended to consider the relationships between different themes. The differences were confirmed in a protocol study with design practitioners, in which experienced designers were asked to design a condiment stand and subsequently explain their process. UK designers were found to be design-attributes oriented, whereas Chinese designers were more use-environment oriented. Also, compared to their UK counterparts, the design processes of the Chinese designers tended to be more simplified.

The differences found in the perspectives of design process and design outcome can be attributed to cultural differences addressed by cultural models such as those from Hofstede. The literature on the cognitive differences between the UK and China also suggested deep-rooted reasons for the relevant differences, such as the analytic cognitive style of UK people and the holistic style of Chinese people, which make them have different focus on interpreting things. The findings of this research offer valuable information in guiding product design activities taking place in the UK / China or any other similar cultures in two ways: 1) the differences in design evaluation criteria offer valuable references to design practice in the relevant markets, i.e. different emphases on the aspects of aesthetics, ergonomics and creativity should be taken when designing for the relevant market; 2) the differences found in design cognition and patterns in design process also provide valuable information: a) for design education, it suggests that Chinese design students should be encouraged to use sketching as a tool for thinking and generating ideas and also to present more of their cognitive process, so as to develop more structured thinking processes to facilitate design; b) for collaborative design practice in a multi-cultural environment, which is typical of today's product industry, it suggests an integration of different views of designers during early design stage to make more thorough investigation of the design problem, and also a more flexible management in the idea developing stage to fit with the different cognitive styles of the designers.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my supervisors, Dr Glyn Lawson, Dr Xu Sun, and Professor Sarah Sharples, for their dedicated support, guidance and abiding encouragement. Sincere gratitude also goes to my examiners, Dr Sue Cobb, Dr Patrick Pradel and Dr Samantha Porter from the University of Loughborough.

I am grateful for the members of the Human Factors Research Group for their support, motivation and friendship. Also thanks to Richard and Simon for their kind help in the PDM design studio and all the participants who took part in the user studies.

Particular thanks go to my dear friends Alan, Setia, Katharina, Katarina, Julie, Juanjo, Tess, Laura, Raphael, Jack, Arzoo, Jeena, Chrissie, for their friendship and all the happy time getting together during my stay in the UK.

My infinite gratitude goes to all my family and friends for their love and continual support throughout the entirety of my PhD. I remain indebted to Wei for his limitless support, encouragement and love.

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Chapter 5

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1 INTRODUCTION

1.1 Introduction

The measurement of cultural differences is always a controversial task. As Ruth Benedict (1947), who was famous for her work in studying culture, says you need tough-mindedness to recognise differences, even when they are disturbing. However, regardless of the difficulty of the task, there is no denying that culture plays a crucial role in many factors that are related to human-beings. Design, as a representative activity of human culture in modern society, is inevitably influenced by the culture. The necessity of bearing users' culture context in design has been suggested and proven by many researchers (Evers & Day 1997; Razzaghi & Ramirez 2009; Reid 2011; Snelders et al. 2011; Van Boeijen & Stappers 2012; Bluntzer et al. 2014). Only by an inclusive understanding of the users and their contexts, in which culture is the most important one, can designers conduct successful design (Oshlyansky et al. 2004).

The comparison between Western and Eastern Asian cultures has lasted for hundreds of years, since the 13th century when the Italian explorer Marco Polo first unlocked the secrets of the mysterious Eastern Asian world to Westerners. Although the globalization since the late 19th century has greatly facilitated communication between the two cultures, the cultural clashes can still be found in every corner of the world in the daily life of people who are living in an environment that are exposed to any culture-related issues. These issues could be dominant like daily routines of eating, dressing, consuming etc.(Hesse-Biber et al. 2006; Lake et al. 2000; Miller & Pumariega 2001; Niinimäki 2010; Hansen 2004; Passini 2013; Tellström et al. 2006); it could also be recessive like cognitive patterns of communicating, understanding, perceiving etc. (Markus & Kitayama 1991; Nisbett et al. 2001; Chiu 1972; Ji et al. 2000). When it comes to product design, any kind of oversight in cultural issue could lead to the failure in the final outcome of the whole design process.

It was towards the goal of understanding the role of culture in the product design activities that this work was conducted. The target cultural groups were focused on UK and Chinese cultures, which are two typical cultural samples from Western and Eastern Asian cultures respectively. Product design in this research was decomposed into two main components: the design outcome and design process.

1.2 Background

Hofstede (2001) claimed that all aspects of human life are influenced by culture. It is of no surprise that both practitioners and academics have begun to have great interest in the role of culture in design activities. The literature shows there were two main types of research investigating the relationship between design and culture according to the two basic components of design practice: Type I looks at the role of culture from the perspective of **design outcome**, namely how culture is maintained in the design outcome and how culture impacts on user's evaluation of design outcomes; Type II investigates the relationship between culture and the **design process**, probing how culture impacts the design process.

Examples of Type I study: There are a large number of studies of this type and the majority of them focused on the realm of Human Computer Interaction: Marcus and Gould (2000) introduced Hofstede's culture dimensions and discussed how they might affect **web user-interface design** using a group of websites from different cultural backgrounds. Marcus (2003) also discussed possible cultural influences on **user-interface design** from the perspective of Chinese culture. Evers and Day (1997) examined user's cultural preferences on **interface design** by interviewing 206 international students plus a control group of 38 Australian students. Snelders et al. (2011) performed two studies to investigate the cultural adaption of web design of small and medium sized ICT companies in Germany and Spain and demonstrated that the cultural adaption of the **web design** had effective influence on the industry styles. The role of culture in other specific design areas has also been explored. Bluntzer et al.

(2014) analysed a group of French and German cars to investigate the relationship between **car style** and cultural preferences. Seva and Helander (2009) studied the cultural difference among users from Singapore and the Philippines on their emotional responses towards **cellular phone** attributes.

Examples of Type II study: Compared to the Type I study, the number of studies looking at culture and design process is quite limited. Razzaghi et al. (2009) conducted comparisons between Australian and Iranian students' design concepts to probe **cultural patterns in product design ideas**. They also analysed the possible cultural influences on the patterns using the cultural models from Hofstede et al. (2001; 2010) and Hall (1989). Choe (2004) conducted an empirical study to investigate the **cultural differences in the amount of information** in the design of information systems, using samples from Australia and Korea. In his PhD research, Moalosi (2007) investigated the **relationship between culture and human-centred design** based in Botswana. Chueng-Nainby (2010) conducted a series of ethnographic studies to describe **concept negotiation during early design collaboration** between Western and Chinese designers.

The research listed above shows the gaps of the research in this area (a more detailed literature review can be found in Section 2.4.1): Firstly, from the perspective of design outcome, there is little research that compares the features of general product designs from designers of different cultural backgrounds, especially from the point of view of the general users. Secondly, from the perspective of the design process, existing research focused more on the explicit cultural patterns or factors in the design process (Razzaghi et al. 2009; Moalosi 2007). Rarely is there research done on the cultural influence on the implicit **cognitive process** during design practice. Some of the research that has looked at the cultural influence on design process, such as Moalosi (2007), focused on student designers rather than industrial practitioners and therefore has limited reference value to real design practice. Furthermore, there is no systematic comparison of product design between the UK and China, which are the respective representatives of Western and Eastern Asian cultures that have significant influence on the global market.

1.3 Research aims

The aim of this research was to investigate cultural differences in product design in both the UK and China. The differences were explored from two perspectives, which are also the two main components of normal design activity, namely design process and design outcome. The following objectives addressed the overall aim.

Objective 1: To develop a background understanding of the concepts of design and culture and also the relationship between the two concepts

The scope of this objective was to obtain background knowledge which could be used to inform the research carried out. This included exploration of the concepts of design and culture, as well as the relationship between the two concepts (see Chapter 2). This objective also included exploring the methodological approach undertaken in the area of studying product design in a cross-cultural context (see Chapter 3).

Objective 2: To investigate the cultural differences in product design from the perspective of design outcome

In this objective, the design outcome was explored from two dimensions: 1. the differences in the features of design outcomes; 2. differences in the evaluation of design outcomes. In the real market, it is not easy to find products that are 'purely' designed by UK or Chinese designers. Study 1 presented in Chapter 4 used designs from UK and Chinese design student to investigate the differences from the two dimensions with groups of UK and Chinese participants. Study 2 in Chapter 5 was conducted to validate the finding of the differences in the evaluation of design outcomes in Study 1 with a larger sample size of participants and in greater detail. The samples of design outcome used in Study 2 were popular products in the UK and Chinese markets.

Objective 3: To investigate the cultural differences in product design from the perspective of design process

The differences in the design process were investigated initially with student designers (Chapter 6) and then validated with design practitioners (Chapter 7) from the UK and China. The differences were investigated from the perspectives of the explicit patterns, namely the contents that are presented in the design representations from the designers, and the implicit cognitive processes, namely the invisible cognitive processes based on which the designer construct the process from design problems to design solutions.

The structure of the thesis is illustrated in Figure 1.1, showing the ways in which the individual chapters correspond to the research objectives. Summaries of each of the chapters of this thesis can be found in section 1.4.

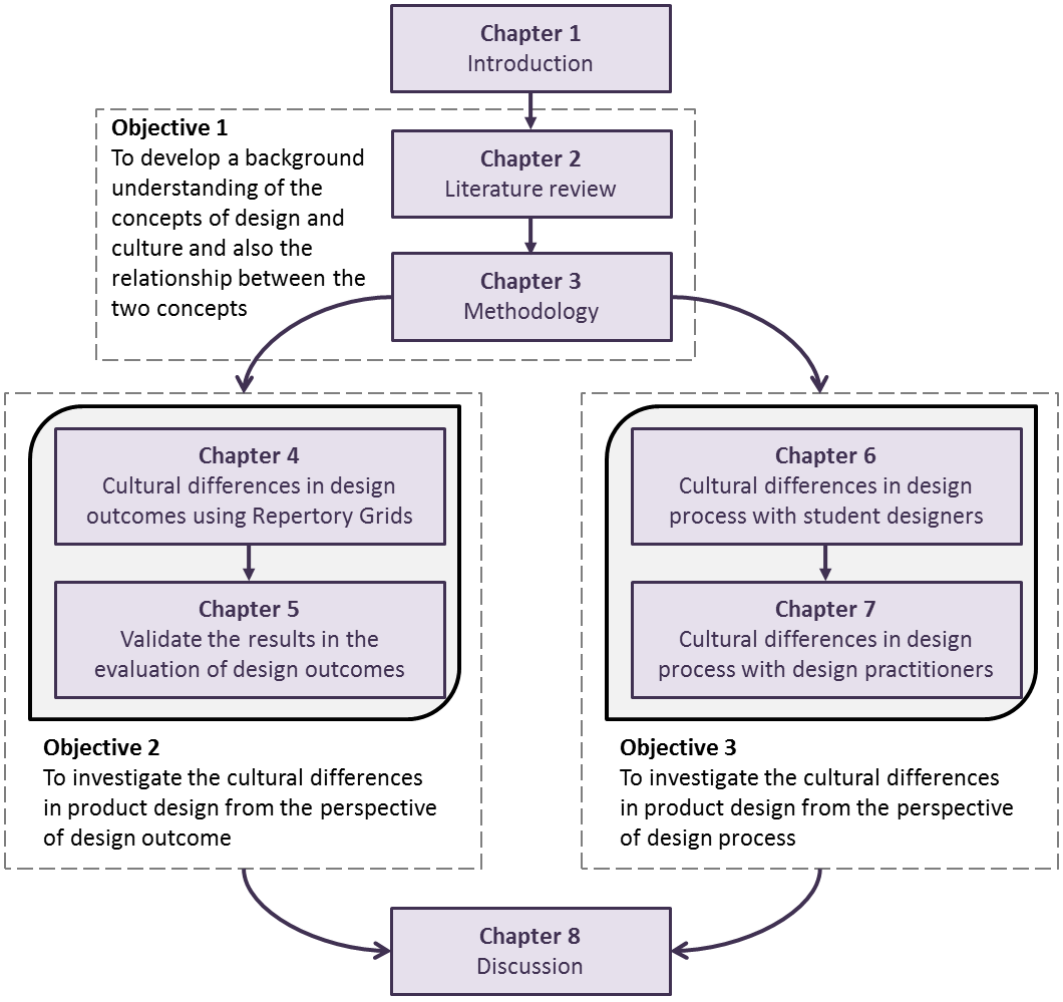


Figure 1.1 Thesis structure

1.4 Thesis overview

This section presents the summary of each individual chapter.

Chapter 2 – literature review

This chapter deals with two key concepts: design and culture. For the design part, it presents a review of two main streams in the history of design methodology and relevant design models. The role of sketching in design, the relationship between design and user, and the main features used in design evaluation are explored. The scope of 'product design' used in this research is defined and the history of product design in the UK and China is introduced. For the culture part, it presents an exploration of the definition of culture and then introduces the cultural dimensions from Hofstede et al. (2010) and Hall (1989). Then, the differences between the UK and China are explored according to the cultural dimensions and also in the systems of thought between the two cultures. Finally, the relationship between design and culture is explored and the relevant existing research is reviewed.

Chapter 3 – General methodology

This chapter describes the methodology used in the research. The methodology is presented in two phases, i.e. the methodology used in exploring the role of culture in design outcome and in design process. It presents a review of the common methods that have been used in this area. Based on existing methods and their adaption to the cross-cultural context, this chapter introduces the methods applied to the research conducted for this thesis.

Chapter 4 – Probe Cultural Differences in Design outcomes using Repertory Grid Analysis (Study 1)

This chapter presents a study with a group of UK and Chinese participants who evaluated 18 designs from UK and Chinese student designers. Repertory grid was used as an interview technique to elicit the differences in the evaluation of the designs. This study was exploratory with the aim of investigating cultural

differences from two dimensions: differences in the features of design outcomes and differences in the evaluation of design outcomes. The finding shows there were distinctive features between the designs from UK and Chinese student designers. The finding also indicates that the evaluation criteria from the two groups of participants differed greatly, especially in the aspects of aesthetics, usability, creativity.

Chapter 5 – An online questionnaire to validate and explore differences in aesthetics, ergonomics in utility and creativity between the UK and Chinese general public (Study 2)

The study presented in this chapter was to validate the results from Study 1 in the differences in the evaluation of design outcome using large samples from the general public of each country. It was also designed to explore the criteria in design evaluation with further details. An online questionnaire was used as the research tool so as to get large random samples. A model of online design evaluation was developed based on the findings in Study 1 and also the relevant literature review. The results confirmed differences in the evaluation criteria between the UK and Chinese general public on the aspects of aesthetics, perceived ergonomics (usability, functionality) and creativity, which also resulted in the differences in the overall evaluation. The two groups of participants were found to have different focuses on each of the aspects. The result of hierarchical regression analyses was applied to the research model to visualise the differences in the design evaluation between the two groups of participants.

Chapter 6 – Probe Cultural Differences in the product design process – study with students in Product Design (Study 3)

This chapter presents a study with student designers from the UK and China campuses of the University of Nottingham. There were two main parts of this study: an ethnographic observation in the design studio on the students' daily design activities and a coding analysis on their design submissions. The ethnographic observation was applied to capture the potential social issues and cognitive factors exist in the design processes. The design submissions were

analysed in a post-hoc reflective way so as to capture the differences in the design cognition between the UK and Chinese student designers. A semantic word cloud analysis was also applied to the design submissions to explore the differences in explicit patterns in formulating design task and addressing design attributes shown in the design process. Differences were found in the design patterns, relating to the use of sketching and also in the numbers of sketches.

Chapter 7 – Probe Cultural Differences in the product design process – study with professional designers (Study 4)

The protocol study presented in this chapter was conducted with design practitioners from the UK and China to validate the differences found in Study 3. The designers were asked to finish a design task within a set time and do a short interview after the task. Compared to Study 3, this study was conducted in a more direct way onto the investigation of the design process. The empirical data was obtained from direct observation of the design process and was confirmed with the individual designers' personal interpretation by interview. The results confirmed the finding in the previous study: the two groups of designers had a different focus when they were constructing the design task. Significant differences were found in the types of sketch and in the numbers of concepts they developed in the design process.

Chapter 8 – General discussion and conclusion

This chapter presents a discussion of the key findings of this research, with references to the literature of the relationship between design and culture. The role of culture is discussed referring to the differences found in design outcomes and design process. Recommendations for design practice based on the findings are proposed and original contributions to the knowledge are also presented. Suggestions for future work are given and the limitations of the research are highlighted.

2 LITERATURE REVIEW

2.1 Chapter overview

The literature review covers three areas: design, culture and the relationship between design and culture. In section 2.2, some main design definitions are reviewed along with the history of the development of design methodology. Design models based on prescriptivism and descriptivism design theory are introduced. From the perspective of design process, the role of sketches is discussed. From the perspective of design outcomes, the relationship between design and the user as well as the features of design are explored. And lastly, it defines the scope of 'product design' in the present research and briefly introduces the history of product design and its education in the UK and China. Section 2.3 investigates the connotation of culture from its definitions and cultural dimensions from Hofstede and Hall. It also discusses some critiques of Hofstede's cultural model as one of the most popular cultural models but also the most controversial one. Section 2.4 discusses the relationship between design and culture.

2.2 About design

2.2.1 Two design paradigms

According to the Cambridge Dictionary of American English, design is "*the creation of a plan or convention for the construction of an object or a system (as in architectural blueprint, engineering drawing, business process, circuit diagram and sewing patterns)*". This definition indicates that there are different fields of design; moreover, the connotations of the word design vary with different fields. It has been a conundrum to achieve a definition that could be accepted world-wide. Nevertheless, the importance of establishing an exact, unambiguous and universal definition of design is undeniable for design practice, design research and design education. The way we see design and designing determines how the design process is described and prescribed and how design study is conducted. To date, many researchers have dedicated their efforts to propose a universally

acceptable definition for design. The definition from Simon (1996) is a repeatedly cited one in design literature. It defines design as “actions aimed at changing existing situations into preferred one”. However, this definition is highly abstract and does not reveal the content of real design activities. Miller (2005) described design as “the thought process comprising the creation of an entity” and asserts that it is “built on a solid foundation of ideas and concepts that will serve as the very root of our philosophy of design”. Nevertheless, this definition is still defective as the content of design activities is obviously more than just a thought process. For example, architectural design also comprises the sketching process and the thought process alone cannot create physical things (Ralph & Wand 2009)

Before getting lost in the sea of various definitions of design, it is worth looking at the development of design methodology since the first paper in early 1960s. Generally speaking, there are two main streams in the history of design methodology: prescriptivism and descriptivism; or as Dorst (1997) suggested: designing as problem-solving—rationalism (prescriptivism) and designing as reflective practice—situationism (descriptivism) (see Figure 2.1). The former one developed from Simon’s (1996, first published in 1969) ‘science of the artificial’ that took design as a rational problem solving process. It claims the comparatively rigid mode of designing—the designers follow a prescriptive design process, from the input of objective analysis of design problems to the outcome with an objective design solution (see Figure 2.1). For this paradigm, problem-solving is the main concern. The later one is a synthesis of the view of the design process that focuses more closely on the practice aspect. It is developed based on two theories; they are the idea of reflective practice (Schön 1991, originally published in 1983) and the notion of situated cognition (Suchman 1987). The focus of this paradigm is the interaction between the designer and the environment of design. As Gero and Kannengiesser (2004) suggested, situationism that gives an appropriate name to the phenomenon that happens in the design process, the designer’s idea depends on what is seen, and design is an iterative process between making and seeing.

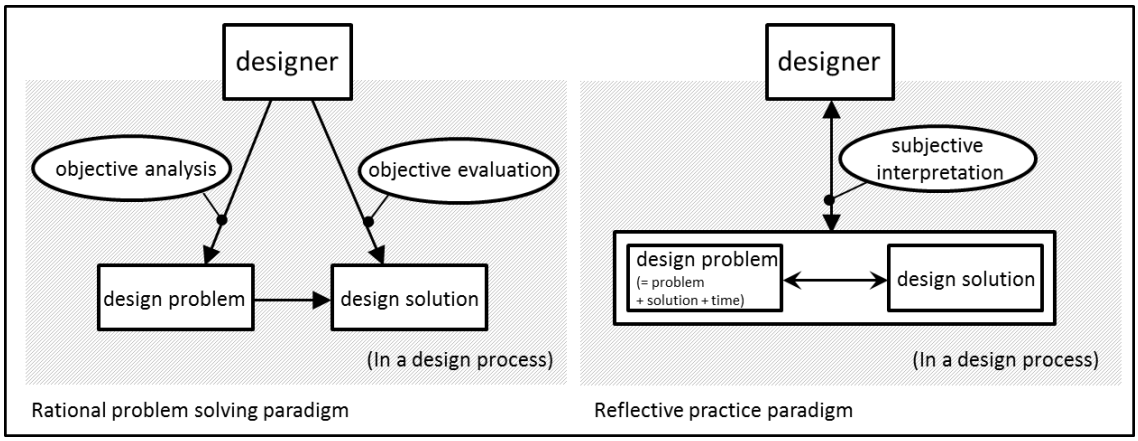


Figure 2.1 Kees Dorst's two design paradigms (Adapt from Dorst, 1997)

The main difference between the two paradigms lies in the sources on which they were developed. The prescriptive paradigm was developed from the theoretical reflection of the insights on the nature of design, while the descriptive paradigm was developed based on the knowledge about real-life design practice. The comparison between these two paradigms against each other has a long history. From the study of Dubberly, et.al (2008), they found that academia tends to suggest prescriptive processes with detailed procedural steps and loops, while practitioners tend to suggest flexible and cyclical descriptive models. These phenomena exist with their realistic base and necessity. Academia uses models of design for the purposes of teaching or studying design activity, which requires relevant rigid paradigms; on the other hand, the practitioners face design practice themselves, which needs them to make a solid analysis of concrete problems at any time, and therefore a descriptive model fits their real experience. One of the reasons that descriptive models are considered to be superior currently is that compared to the prescriptive ones, they reflect the real design process, which is also the ultimate goal of design education and research.

It is undeniable that both of these paradigms have things to recommend them. A prescriptive paradigm focuses on the process-component of design activities and is good at revealing the reasons behind the designers' actions and helps to understand the whole design process in the logical way; however, it also lacks of real understanding of designers' specific activities and is easy to become arbitrary when faced with the complicated nature of design activity (Dorst, 1997). On the

other hand, a descriptive model fits to the process when the designer is experimenting with problem/solution structures and also links design process, task and designer in a more organic way; however it has the shortcomings such as the lack of clear frame and the difficulty of developing methods based on its underlying theory (Dorst, 1997). According to Dorst (1997), there are differences in the levels of understanding of design practice that can be addressed by each paradigm and the descriptive capabilities of each paradigm vary with the phase of a design activity applied. In his thesis, Dorst also demonstrated the feasibility of combining two paradigms as one design model from a theoretical point of view. As he claimed, the design activities that involve more about 'objective interpretation' would be described well by the prescriptive paradigm and the ones that more involve 'subjective interpretation' are better described by the reflective paradigm. A combination of the two paradigms will make the study of the design process more feasible and practical and this was the guiding principle of the research conducted for this thesis in the use of design models.

2.2.2 Models of design

2.2.2.1 Models of prescriptivism

The prescriptive paradigm that takes design as a rational problem solving activity deals with the process-components of design activities (Dorst, 1997). Many researchers have tried to develop a model or map to simulate the design process from the beginning to end and the majority of them were developed based on the design methodology of prescriptivism.

Ralph & Wand (2007) did a review and analysis of existing definitions of design and proposed a design model that was claimed to be "generally-accepted, precise and useful". In the model, they introduced eight components to explore the content of design activities. They are **specification**, **object**, **agent**, **environment**, **goals**, **primitives**, **requirements**, and **constraints**. A **specification** here is a detailed description of a design object's structural properties. "It may be purely mental, provided in a symbolic representation, presented as a physical model, or even manifested as the object itself." (Ralph & Wand 2009) The **object**

refers to the entity being designed (which is not necessarily a physical object). The **agent** is the subject of the design process, which refers to the entity or group of entities who manifests the design. **Environments** here refer to two different types of environment, associated with noun form and verb form respectively. In the noun form, it refers to object environment—the context or scenario in which the object is intended to exist or operate; in the verb form, it refers to the agent environment—context or scenario in which the design agent creates the design. **Goals** are the desired impacts of design object on its environment, which capture the various objectives that may exist at different levels of abstraction (Van Lamsweerde 2001). **Primitives** refer to the set of elements that compose the design object. This definition also mentions **requirements** and **constraints**, which refer to structural or behavioural property and restriction that a design object must possess respectively. By using all the components, they modelled design as a process "to create a design, in an environment (where the designer operates)" (Figure 2.2). The components of **goals**, **primitives, environment, requirements** and **constraints** work together as the inputs of the design process, with the output of the **specification of object**.

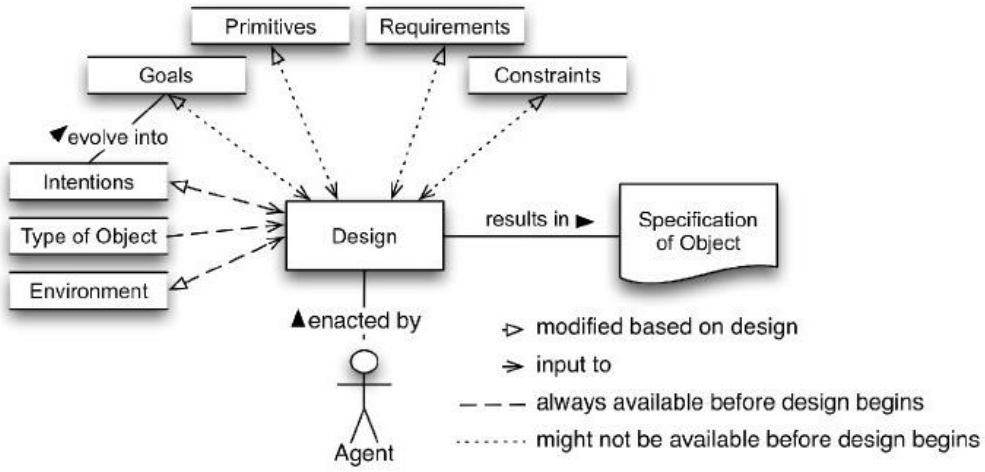
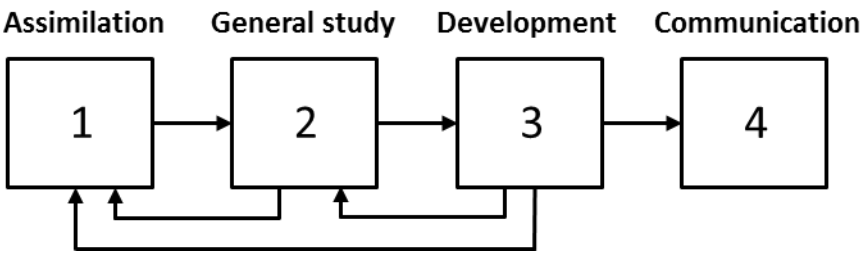


Figure 2.2 Context-level Conceptual Model of Design (as a verb) by Ralph and Wand (2009)

Instead of decomposing the design process into the detailed inputs and outputs, the map from the RIBA Architectural Practice and Management Handbook (1965,

cited by Lawson 2006) focused on the actual procedure of the design activity. It divided the design process into four phases (Figure 2.3).



Phase 1 assimilation

The accumulation and ordering of general information and information specifically related to the problem in hand.

Phase 2 general study

The investigation of the nature of the problem. The investigation of possible solutions or means of solution.

Phase 3 development

The development and refinement of one or more of the tentative solutions isolated during phase 2.

Phase 4 Communication

The communication of one or more solutions to people inside or outside the design team.

Figure 2.3 A map of the design process from Architectural Practice and Management Handbook (1965, cited by Lawson 2006)

This map simulates the design process as a sequential process, but not necessary in the order from Phase 1 to Phase 4 as also revealed in the RIBA handbook. As Lawson (2006) pointed out in his book, in reality it could be difficult for the designer to know what information to collect in Phase 1 until they have investigated the design problem in Phase 2. Also the designer would find out more about the problem in Phase 3 when developing the solution and goes back to Phase 2 for further study. The map also indicates the potential jumps between Phases 1, 2 and 3, although the reality is always much more confused. The map

describes the design activity as a process of “gather information about the problem, study it, devise a solution and draw it” (Lawson 2006), which is highly condensed but also relatively accurate in summarising the actual situation.

2.2.2.2 Models of descriptivism

As Dorst (1997) suggested in his thesis, the prescriptive paradigm takes design as a rational problem solving process and focuses on the components, which inevitably misses some links between the components and leads to failure of understanding the real situation. On the other hand, the descriptive method that describes design as a reflective structure tries to preserve the links between design process, task and designer, but lacks the clarity and rigour which could be achieved by the prescriptive paradigm. As mentioned above, the descriptive paradigm was developed in Schön’s (1991) “reflection-in-action” theory. In reflective practice design task and solution are always and inherently developed together because the designer takes it as an action in structuring and solving the design problem and do not prioritise any potential approach. The design is taken as a dynamic **move** which progresses through time rather than as a static topic or concept.

Design models based on the theory of descriptivism are not as straightforward as the ones on prescriptivism that are simulating the complete design process. Schön (1991) presents a ‘mechanism of design’ using the cycle of **naming, framing,** and **evaluating** (Figure 2.4). It describes a loop of actions that happen in a design process from the point when the design object is determined and put into a context to construct an overall perspective of the design task to the point when a designer takes an experimental action based on the previous steps and with the action been evaluated. The final evaluation of each loop could lead to satisfaction, or reframing, or even a new start by naming new entities. The loop represents only a basic unit of the complete design process. In Dorst's (1997) study, he applied the reflective paradigm by encoding the design protocol into categories of names, moves and frames to do a textual analysis.

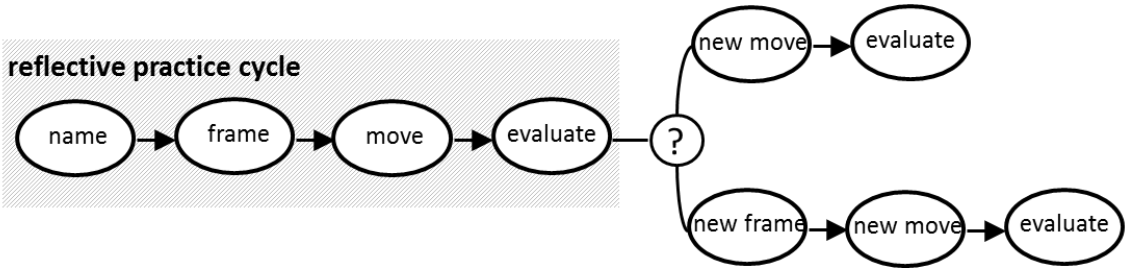


Figure 2.4 The basic cycle of reflective practice (Adapt from Dorst, 1997)

The encoding system applied by Dorst depends heavily on a consistent identifying principle and notation for each categories, which is only applicable when the design process is closely observed and recorded. Actually there is a more simple way to construct the reflective process of the design activity. Dubberly et al. (2004 cited by Chueng-Nainby 2010) summarized from design models across the design disciplines and from design practice, design research and design education, and found that they all start with a simple problem-to-solution progression in a linear process (Figure 2.5). In this process the design problem is the input and the output a design solution. This process is reported as the basis of the design process just as the "name – frame – move – evaluate" process from Dorst's model. It can be expanded into the frameworks presented in Figure 2.6 and 2.7. Dubberly (2008) mentioned that one risk in using these framework is that they simplify the design process by promoting an illusion of linearity and a mechanism – of cause and effect. It is difficult to relate these frameworks to the design reality if they were taken as a linear process. Actually a perspective of the holographic principle could offer a more close-to-reality understanding of these frameworks (Bohm 2005). According to Bohm, there are two basic principles of the "Holomovement": any part contains all the information of the wholeness and a lower dimension contains all the information from a higher dimension. The design process could be interpreted in its wholeness as the movement from design problem to design solution and within it are many basic processes of 'problem-to-solution'; the basic 'problem-to-solution' process is in a two-dimensional linear mode and the overall process from design problem to design solution is a three-dimensional model rather than an extended linear process.

Any basic 'problem-to-solution' process reflects the information about the overall process from design problem to the design solution.

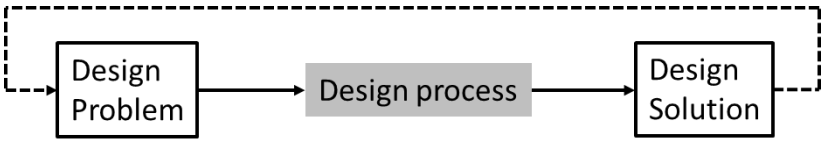


Figure 2.5 The early stage of designing (Dubberly et al, 2004 cited by Chueng-Nainby 2010)



Figure 2.6 Process archetype, adopted from (Dubberly 2008)

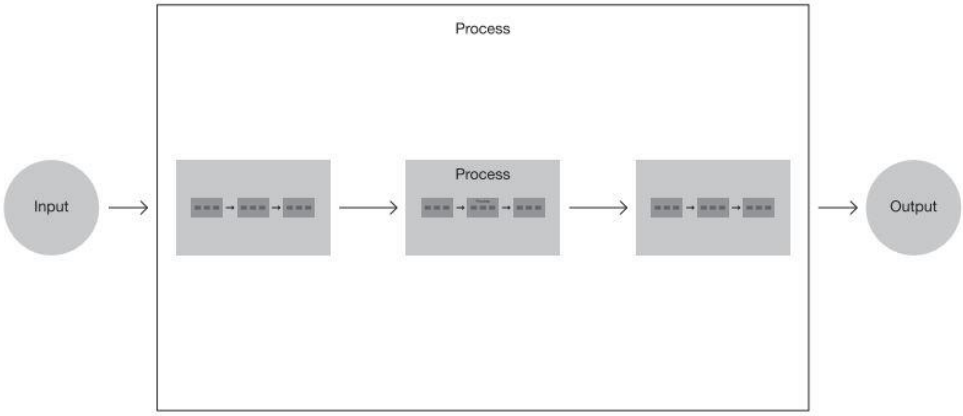


Figure 2.7 The infinite expandability of processes models, adopted from (Dubberly 2008)

This perception of the design process is in agreement with the interpretation from Gero and Mc Neill (1998) who defined the conceptual design process as "the designer navigates through an abstract problem domain and employs various strategies to elaborate to the problem description" and divided design into the problem domain and the strategies. In the problem domain, they also identified the shifts of the designer's attention from high level views of the problem down to low level details of the problem. For the strategies, they claimed that the designer's activity consists of a sequence of actions or micro

strategies each lasting for a very short period of time with the strategies self-contained and only relating to the current state of the process.

Compared to the model adopted by Dorst, this cyclical model is much simpler and echoes the "ill-defined problem" nature of the design process. As Cross (2001) asserts, when analyzing design cognition, language and concepts from cognitive science studies of problem solving behavior are normally used. It has long been considered in design methodology that design is taken as a process starting from a design problem and "searching for a solution through a vast maze of possibilities" (Simon 1996). The reality is, in a design project the problem may be some loosely defined problem by the client, with many un-explained constraints and criteria. As Akin (1986) stated it, the constant generation of new design goals and redefinition of constraints is always expected in design behaviour. Based on the ill-defined nature of the design problem, Cross (1999, 2001) concluded that design is exploratory, opportunistic and ambiguous and solution-led. The identification of the problem inevitably results in making a decision and to modern thinking design problems and solutions are emerging together instead of one flowing logically upon the other (Lawson 2006). Therefore the design model in Figure 2.7 also echoes with the nature of design process from the perspective of design cognition.

2.2.3 Product design and its education in the UK and China

Design methodology is defined as the study of the principles, practices and procedure of design (Cross 1984). According to Dorst (1997), design methodology can either be a theoretical science when its subjects are logical models of the design process, or an empirical science when its subjects are real-life design activities. In the research of this thesis, design methodology was used in both ways. The logical design models introduced in Section 2.2.2 were used to describe, model and explain real-life design activities. Although the theoretical aspect of design methodology makes it domain independent, when faced with real-life design activities, there are real differences between the end products created by designers in different fields such as fashion design, interface design,

architecture, interior design, product and industrial design, urban and landscape design, etc. (Lawson 2006). From the perspective of design practice, the subject of design in this research was focused on product design or industrial design.

Although there has been some debate about the definition and differentiation of product design and industrial design, in this research, the two concepts are used to present the same domain. There have been many definitions of product design. The Industrial Design Society of America (2016) states:

"Industrial design is the professional service of creating products and systems that optimize function, value and appearance for the mutual benefit of user and manufacturer."

Essentially, as Dorst (1997) concluded, the domain of product design has the following essential attributes:

- The objects are mainly consumer products, 'ranging from teaspoons to cars' and most practitioners work on a large range of products.
- It concerns the designer, the producer, the user and the society as a whole.
- The design process needs to take into consideration the technical, ergonomic, aesthetic and business contexts.
- The products are meant for mass production, therefore issues with the material, production and assembly costs have to be considered.

Product design is a relatively young profession. In the West, although industrial design was commonly incorporated into industry by the end of the nineteenth century, it was not until the middle of the last century that product design slowly emerged from disciplines such as mechanical engineers, artists and architects as a speciality (Dorst 1997; Sparke 2013). Product designers were initially taken as specialists who only gave form to products but had nothing to do with the technical aspects. Until the end of the last century, such industrial designers were being trained in art schools all over the world. In the UK, since the end of the last century, there have been specific faculties from different universities offering education for generalists capable for integrating the aspects of form, ergonomics,

commercial consideration and engineering issues into product design. Take the course of Product Design and Manufacture BEng at the University of Nottingham as an example: The students in this course, in addition to training in design skills, would be given a broad foundation in engineering science and design, manufacturing process, material selection and behavior, mathematics and business studies.

The development of product design in China is greatly influenced by Western countries which can be traced back to the end of the nineteenth century during the Reform in the Late Qing Dynasty that advocated to learn from the Western civilization (Liu 2015). It also had been influenced by the Soviet-style design for about two decades since the founding of the People's Republic of China. China has been well-known as a global manufacturing centre since the 1990s and is now on its way to being a design centre (Chueng-Nainby 2010). The product design education in China is still underdeveloped compared to some developed countries. According to Shen and Zhang (2001), in 1960s, there were only two schools offering courses in product design, which were taken as an extension of art education. The growing market since the 1990s brought the integration of design education with other disciplines such as marketing, manufacturing and engineering science. Product design courses started to emerge fast in engineering schools. However, the integration between the disciplines is facing big challenges (Deng & Fan 2013). For many product design courses, the rough combinations of different courses and immature systems make it difficult for graduates to meet the requirements of being designers in the market. The mode of design education in China is greatly influenced by German, Japanese and Russian education (Liu 2015; Yuan 2003; Shen & Zhang 2001). But there are also doubts about the usefulness of adapting foreign design education models directly into the Chinese context (Deng & Fan 2013; Shen & Zhang 2001). On the other hand, the immature Chinese education in product design is facing an intense international competition due to the open market and there is a tide of Chinese students taking education in product design overseas. The challenges faced by

the design industry and education system indicate it is now going through a transitional period.

2.2.4 The role of sketching in design

There is a long history of drawing and sketching being used in design, which starts long before the Renaissance, but with little change in its main attributes (Fish & Scrivener 1990). The sketches, which are typical forms of pictorial representation in the design process, have long been considered to be an essential part and also the main method the designer applies to communicate their design ideas (Rodgers et al. 2000; Tovey et al. 2003). It has the important function of assisting the designer to translate descriptive propositional information into depiction and also performing as a thinking and reasoning aid. It helps the designer to consider many aspects at once – plans, elevations, details and trajectory lines – all being drawn together – providing an object for being thought and reasoned about together. One feature of sketching is that it always contains more than one drawing for one solution. It is due to the nature of the design problem which can only be found by exploring it through alternative proposals. Sketches provide the identification of critical details, with which the designer can identify and recall relevant knowledge. Sketches also assist problem structuring through solution attempts and promote the recognition of emergent features and properties of the solution concepts (Cross 1999).

From the point of view of design methodology, sketches also play a key role in understanding the cognitive processes taking place in the design activities, especially in the aspect of problem solving (Purcell & Gero 1998). Usually, as the design progresses, the forms of the pictorial representations used would evolve from relatively unstructured to more structured (Rodgers et al. 2000; Purcell & Gero 1998). In the engineering context, five levels of complexity have been identified for concept sketches (Rodgers et al. 2000; McGown et al. 1998; Tovey et al. 2003).

Complexity level 1

Monochrome line drawing, no shading or colour, uniform line thickness

Complexity level 2

Monochrome line drawing, no shading or colour. Line thicknesses vary to give emphasis. May include brief annotation.

Complexity level 3

Monochrome with rough shading to suggest form. May be annotated.

Complexity level 4

Line and shading, may include colour and graduation.

Complexity level 5

Colour illustration to show what the product looks like colour, shading, shadows, annotations, dimensions.

The complexity of the sketches also varies according to the different purpose of each sketch. The function of sketches in the design process has been identified and confirmed by many researchers (McGown et al. 1998; Seitamaa-Hakkarainen & Hakkarainen 1995; Rodgers et al. 2000; Lawson 2006). Seitamaa-Hakkarainen & Hakkarainen (1995) identified three types of sketching in their study: 1. **thinking sketch** (used to represent an initial unarticulated design idea that is based on only a few design elements, 2. **prescriptive sketch** (used to represent a further articulated and detailed design including consideration of several design elements and, frequently, an initial scaling) and 3. **alternative** (used to represent a detailed and fully articulated design that could, in principle, be produced). The three types of sketches were identified by taking into consideration the design process and based on the functions of sketching as a tool for aiding design thinking and presenting design solutions.

2.2.5 Design and the user

Although the design definitions or models rarely mention the user, it is undeniably one of the key influential parts in the whole concept of design. As a response to the deficiencies in the existing models of how use and users are taken as part of the design process, experience design or user centred design has gained increasing attention in the development of the design subject (Redström 2006).

In the history of design, there has been a shift from focusing on the design objects to the users. Redströ (2006) summarised the development of design concepts from merely being about the form to focus on the function, and then as a communication process in a semiotic stance and finally to focus on the results, namely the user's experience of the object. In the concept of user experience, the user is always a core notion. When design transfers from being a matter of physical form to being focused on the user and their experiences, it is the people instead of the material object that becomes the focus of design activities. Design is not only about fitting in terms of utility or usability but also interpretation, understanding and experience; it is also about making people fit into systems, societies and strategies. To understand and also to integrate the needs, desires and experiences of people to the design process has become an essential subject in design.

User-centred design, which is defined as a design approach that focuses on the needs of the end users (Gould & Lewis 1985; Lai et al. 2010; Griffin & Hauser 1993; Gulliksen et al. 2003), has developed to understand the users and aid the design process. The term 'user-centred design' was originally proposed by Donald Norman and became widely used after his co-authored book User-centred system design (Abras et al. 2004). With the development of user-centred design, the requirement to fully explore the needs and desires of the users and the intended uses of the product has also been stressed. However, how to involve the users is always a problem when conducting design, even though its importance has been emphasised unprecedentedly. Different ways of involving

users in design have been suggested by researchers (Preece et al. 2002) such as background interviews and questionnaires, sequence of work interviews and questionnaires, focus groups, on-site observation, role playing, walkthroughs, simulations, usability testing, interviews and questionnaires. These tools could be applied at different stages of the design cycle to examine different aspects of the potential user experience so as to optimise the design by decreasing the gap between the potential design solution and the actual needs of potential user.

According to Sun's (2009) literature review, user experience is contingent on a number of distinctive aspects: **user aspects**, the personal aspect associated with emotions, past experiences, needs and expectations; **social aspects**, which is taken as a stage in developing user experience; **usage context aspects**, which refers to the physical and social context when the usage takes place; **cultural aspects**, which refers to the cultural background of the user; and **product aspects**, the perception from the user about the instrumental and non-instrumental quality of the product. The cultural aspect of user experience is one of the main themes that is investigated in the present research. As Arhippainen & Tähti (2003) pointed out, the particular context of use in which the user and the product interact are influenced by both social and cultural factors. The alignment of cultural norms and design activities may play a vital role in creating satisfied user experience. From the connotations of each aspect of user experience mentioned above, it is not difficult see that all the other aspects, such as the past experiences, needs and expectations from the users, the social aspects, and the social context of the usage context, are more or less correlated to the cultural aspects of user experiences. The cultural aspects act as the macro-background of the whole user experience and therefore also create a feedback loop with the whole design process.

2.2.6 The features of product design outcome

In the model from Ralph & Wand (2007), the outcome of the design process is defined as the design **specification**, which stands for a detailed description of an object in terms of its structure, namely the set of elements that compose the

design object. The previous section has introduced the tight relationship between the user and the design. This section looks at the main aspects that the users consider when evaluating designs. By referring to the literature, which was narrowed down to the domain of product design, it is expected that **aesthetics**, **ergonomics** and **creativity** are amongst the most highlighted aspects when evaluating product designs (Carbon & Leder, 2007; Dorst & Cross, 2001; Yamamoto & Lambert, 1994).

Aesthetics is one of the most important features of a design. It is inherently linked to design because that 'design', as it is used to refer to a particular product configuration, is the organization of physical form that inevitably encompassed aesthetic aspects (Veryzer & Veryzer 1995). Some researchers also attribute great weighting to aesthetics because it has significantly impacts on other aspects of a design such as perceived usefulness, ease of use, enjoyment, effectiveness and efficiency etc. (Quinn & Tran, 2010; Yamamoto & Lambert, 1994). It is therefore a critical determinant of consumer response and product success (Crilly et al. 2004). Hekkert (2006) defined the aesthetic experience of a product as the degree to which all the senses are gratified. He claimed that the aesthetics should be attributed to the areas of vision, sound, touch, smell/taste, and mind. In this PhD research, as the materials used as design samples were either sketching or pictures of designs, the aesthetics investigated were limited to visual aesthetics, which is also the most important aspect in the evaluation of aesthetics. There is a great deal of research that investigates the visual aesthetics attributes of product design. Among them there is a mainstream that specially examines the visual aesthetics that are associated with user experience from the perspective of the consumers (Veryzer & Veryzer 1995; Blijlevens et al. 2009; Sonderegger & Sauer 2010). According to the literature, when evaluating visual aesthetics attributes, **colour**, **shape**, **texture**, **materials**, **style** are the common physical properties that were perceived, which together generate certain appearance attributes associated with the overall design experience (Blijlevens et al. 2009).

Ergonomics in design usually concerns the way people interact with the design and its use has evolved with the development and maturity of the market. Traditionally, it has been simply about interpreting data about people, their behaviour and cognition and is more related to functional, performance-related issues such as safety, usability, ease of use and effectiveness (Fulton Suri & Marsh 2000; Stanton & Young 1997). Then it was extended from the objective performance to more subjective aspects such as emotional, experiential aspects that were closely related to product image, impression, lifestyle-fit etc. (Han et al. 2000; Fulton Suri & Marsh 2000). The ergonomics aspect of a design outcome relies heavily on the user-centred approaches applied in the design process. The design is expected to meet the users' needs, which can be influenced greatly by the users' different skills, knowledge, age, gender, literacy, income, culture etc. (Shneiderman 2000).

Creativity adds value to products by not only adding quality and aesthetics to product features, but also emotional impact and identity (Horn & Salvendy 2006). It plays an important part in the design outcome and has been explored by many researchers (Horn & Salvendy 2006; Horn & Salvendy 2009; Oman et al. 2013; Thang et al. 2008; Cropley 2000). In most studies, creativity concerns two attributes, originality and valuableness(Horn & Salvendy 2006). However, these two attributes are never easily quantified and evaluated. Researchers normally define and evaluate it in several dimensions using an assessment model. Cropley and Cropley (2005) developed a four-dimensional scale for defining the creativity of products: relevance and effectiveness, novelty, elegance and generalizability. Horn and Salvendy (2009) proposed a six-dimensional model that consists of novelty, resolution, emotion, centrality, importance, and desire to measure consumer perception of product creativity.

2.3 About culture

2.3.1 The definition of culture

Similarly to the definition of design, there is no universal terminology for culture. The definition of culture varies with the classification of research and its context-

of-use. The number of definitions increases with time, though they are often vague and overly generalised. Taras et al. (2009) described this kind of development in the definition of culture as increasing the richness of the construct but unfortunately doing nothing to increase clarity. Therefore, there is such a conclusion that "culture is one of those items that defy a single all-purpose definition, and there are almost as many meanings of 'culture' as people using the term." (Ajiferuke & Boddewyn 1970).

Although the definitions of culture are worded differently and emphasize different elements and are inevitably vague and general, there are still some obvious similarities. According to Taras et al. (2009), most of the definitions of culture are based on two assumptions: firstly, it is assumed to be stable at both the national and individual levels; secondly, it is supposed to be shared by individuals in the cultural entity.

British anthropologist E. B. Tylor established the first scientific definition of culture in 1871. He defined culture as a 'complex whole' which "includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society". Almost a century later, Hofstede et al. (2010) extended it to "the collective programming of the mind that distinguishes the members of one group or category of people from others", which is one of today's common understandings of the term. Compared to the initial definition, Hofstede's emphasizes more about the stability of culture as it is described as 'software of mind'. Hofstede is not alone, Hall (1989), who viewed culture as often subconscious, also compares it to an invisible control mechanism operating in people's thoughts. Before Hofstede, Kroeber and Kluckhohn (1952 cited by Reid, 2011) define culture as shown below; it is not difficult to find the roots of Hofstede's definition:

> *"…patterned ways of thinking, feeling and reacting, acquired mainly by symbols, constituting the distinctive achievements of human groups, including their embodiments in artefacts; the essential core of culture*

consists of traditional (i.e., historically derived and selective) ideas and especially their attached values."

The second assumption of Taras et al. (2009) about culture definition claimed that culture is shared by individuals in the cultural entity, from which a conclusion can be drawn that; it is possible to distinguish cultures of different societies (Geertz 1973; Kluckhohn & Strodtbeck 1961). Schein's (1984) presented a similar view in his definition of culture, he claimed that the pattern of some basic assumptions adopted by a given group to cope with certain problems would also teach new members the correct ways to perceive, think and feel the relative problems. In the assertion from Hall (1989), this view is obvious: he argues that culture is capable of separating one thing from another by drawing a line that seems to be arbitrary but treated as real once it has been learnt and internalized.

2.3.2 Models of culture

Culture is a complex concept, therefore Evers and Day (1997) argued that, instead of being described, 'culture must be interpreted'. Taras et al. (2009) also asserted that a single model cannot represent a multidimensional and multi-layered phenomenon such as culture. The complexity of the nature of culture implies it is to be interpreted more systemically and hierarchically, rather than from single definitions. By identifying a number of cultural dimensions that are used to study culture, cultural models are introduced (Fryberg & Markus 2007). As Kluckhohn (1952 cited in Hofstede 2011) claimed, principally, underlying the apparent and striking facts of cultural relativity, there is a generalized framework that provides approved and sanctioned ways of dealing with some universal circumstances.

Among the culture models emerging along the history of culture study, the models of Hofstede (2010, first introduced in 1980), to date, are the most popular ones which have proved especially useful for understanding cultural patterns. Before the advent of Hofstede's model, many other researchers tried to categorise culture in terms of unique value orientations. Talcott and Shils (1951) proposed that all human behavior is determined by five pattern variables, which are: affectivity vs. affective neutrality, self-orientation vs. collectivity-orientation,

universalism vs. particularism, ascription vs. achievement, and specificity vs. diffuseness. Kluckhohn and Strodtbeck (1961) identified five value orientations and claimed that they are common to all cultures. Their human-centred orientations mainly dealt with the human nature, and the relationship between the human and the circumstances – nature, time, activity and also other human beings. Later in 1969, Inkeles and Levinson (cited in Hofstede 2011) suggested three standard analytical issues from the perspective of psychology, which have functional significance for societies and groups and individuals within these societies: relation to authority, primary dilemmas or conflicts and ways of dealing with them, and conception of self. It is not difficult to find the basis of Hofstede's model from these groups of cultural value dimensions. In fact, besides the mentioned models, many researchers followed this approach to establish unique value orientations to categorise culture. However, as Taras et al. (2009) argued, most of the research is limited to the subject scales of only one or very few national cultures. Hofstede's study breaks the limitation, which originally studied 40 nationalities but was subsequently enlarged to cover a sample of over 70 nations (Hofstede et al. 2010).

2.3.2.1 Hofstede's cultural model

The original cultural model developed by Hofstede identified four fundamental value orientations that could be used to distinguish national cultures. They are 'power distance', 'masculinity vs. femininity', 'individualism vs. collectivism', 'uncertainty avoidance'. Then in 1988 and 2010, two new dimensions were added, they were 'long-term vs. short-term orientation' and 'indulgence vs. restraint' (Hofstede et al. 2010). As conceptualizing culture as 'programming of the mind', Hofstede focuses his model on "determining the patterns of thinking, feeling and acting" to form a culture's mental programming. He claimed it to be related to very fundamental problems that face any human society, but to which different societies find different answers therefore any country can be placed relative to other countries according to each of the dimensions. A brief explanation of each of these dimensions is presented below (Hofstede et al. 2010).

• Power distance

Power distance is "the extent to which less powerful members of institutions and organizations within a country expect and accept that power is distributed equally" (Hofstede et al. 2010). The two opposing sides to this dimension are high and low power distance. Hofstede claims that high power distance countries tend to have centralized political power and exhibit tall hierarchies in organizations with differences in salary and status. On the other hand, low power distance countries tend to view subordinates and bosses as closer together and more interchangeable. Hofstede calls it the “interdependence among boss and subordinate”, which means a limited dependence of subordinates on bosses and a preference for consultation.

• Masculinity vs. femininity

Masculinity vs. femininity refers to gender roles, as opposed to physical characteristics, of which masculinity means societies with clear distinction among emotional gender roles, whereas femininity refers to societies with overlaps of emotional gender roles. In a masculine society, "men are supposed to be assertive, tough, and focused on material success, whereas women are supposed to be more modest, tender, and concerned with the quality of life". In contrast, in feminine society, both men and women are supposed to be modest, tender, and concerned with the quality of life.

• Individualism vs. collectivism

Individualism vs. collectivism refers to the role of the individual and the group and is characterized by the level of ties between individuals in a society. The two opposing sides are individualism and collectivism. Individualism societies have loose ties between individuals. Individuals are only expected to look after themselves and their immediate family. While people in collectivism societies are integrated into strong, cohesive groups which are supposed to protect them throughout their lifetime as a reward of unquestioning loyalty.

• Uncertainty avoidance

Uncertainty avoidance relates to the way in which people cope with uncertainty and risk, which refers to the extent to which members of a culture feel threatened by the ambiguous or unknown situations. The two opposing sides to this dimension are high uncertainty avoidance and low uncertainty avoidance. High uncertainty avoidance cultures try to minimize the possibility of unstructured situations by proliferating laws, rules and safety and security measures, and, on a philosophical and religious level, by believing in absolute truth. In contrast, people in low uncertainty avoidance cultures tend to be more tolerant of a range of different opinions, they prefer fewer rather than more rules, and on the philosophical and religious level, are more relativist and tolerant of different faiths and creeds.

• Time orientation

Time orientation refers to people's concerns with the past, present and future. The two opposing sides to this dimension are short-term orientation and long-term orientation. Long-term orientation stands for "the fostering of virtues oriented toward future rewards—in particular, perseverance and shift". In contrast, short-term orientation stands for "the fostering of virtues related to the past and present—in particular, respect for tradition, preservation of 'face', and fulfilling social obligations".

• Indulgence vs. Restraint

Indulgence vs. Restraint refers to happiness at the national level and correlates with three items: happiness, life control and the importance of leisure. Indulgence is defined as "a tendency to allow relatively free gratification of basic and natural human desires related to enjoying life and having fun". Its opposite anchor, restraint, stands for "a conviction that such gratification needs to be curbed and regulated by strict social norms".

2.3.2.2 Critiques of Hofstede's cultural model

Since its publication, Hofstede's cultural model received mixed reviews. It receives continuous criticism and scrutiny, which is mainly for its: 1)

unrepresentative samples and small scales (Mcsweeney 2002); 2) flaws in methodology and measurement (Mcsweeney 2002; Fang 2003; Roberts & Boyacigiller 1984; Fang 2010); 3) limited precision / inconsistencies between the cultural categories (Signorini et al. 2009; Bearden et al. 2006).

One typical challenge for Hofstede's model is from Baskerville (2003), who published a paper titled 'Hofstede never studied culture'. Baskerville conducted an analysis of the citations of Hofstede from 1981 to 1998 and found that Hofstede's cultural dimensions are not widely used in social sciences of sociology and anthropology—two disciplines that are supposed to be closely related to culture. She analyses five main reasons—which are also the main flaws of Hofstede's theory— 1) the assumption of equating nation with culture, 2) "the difficulties of, and limitations on, a quantification of culture represented by cultural dimensions and matrices" 3) the status of the observer outside the culture; 4) the use of other national data, most of which could be identified as socio-economic rather than cultural dimensions; and 5) "a general lack of confidence in the assumption of stability of cultural differences", considering cultural diffusion and the dynamism of both national and ethnic shifts (Baskerville 2003). Based on these reasons, Baskerville concluded that Hofstede 'never studied culture' and his model contains not cultural dimensions but only 'reflects mechanisms of social organization, or strengths and opportunism of different nations, which may be epiphenomenal to historical origins'.

In the reply to Baskerville's criticism, Hofstede disproved that his work is not cited by sociologists. He argued that it was due to the different nature of anthropology and business studies that his work is not cited widely by anthropologist. Hofstede also asserted that replications of his work should meet the qualifications such as samples should be well matched, questions well formulated to deal with the same issues and statistical analysed correctly carried out. Three main reasons were concluded to explain why those replications fail to concur with his findings; they are a) statistical, b) methodological, or 3) epistemological (Hofstede 2003).

In fact, in the 2001 edition of Culture's Consequences (p.73) Hofstede lists five standard criticism of his approach found in the literature and gives his responses, as shown below:

Table 2.1 Five Criticism of Hofstede's Cultural Dimensions and Hofstede's answers (Hofstede 2001)

Criticism from the literature	**Hofstede's response**
1. Surveys are not suitable way of measuring cultural differences.	They should not be the only way.
2. Nations are not the best units for studying cultures.	True, but they are usually the only kinds of units available for comparison, and they are better than nothing.
3. A study of the subsidiaries of one company cannot provide information about entire national cultures.	What were measured were differences between national cultures. Any set of functionally equivalent samples from national populations can supply information about such differences. The IBM[1] set consisted of usually well-matched samples for an unusually large number of countries. The extensive validation in the following chapters will show that the country scores obtained correlated highly with all kinds of other data, including results obtained from representative samples of entire national populations.
4. The IBM data are old and therefore obsolete.	The dimensions found are assumed to have centuries-old roots; only data that remained stable across two subsequent surveys were maintained, and they have since been validated against all kinds of external measurements; recent replications show no loss of validity.
5. Four or five dimensions are not enough.	Additional dimensions should be both conceptually and statistically independent from the five dimensions already defined and should be validated by significant correlations with conceptually related external measures; candidates are welcome to apply.

Some of the answers maybe sound like sophism, and criticism does not stop after these responses. As a response to these criticisms of Hofstede's classification of culture dimensions, other models have been developed to overcome its apparent

[1] The data of Hofstede's studies were collected from IBM employees.

limitations such as the value scheme from psychologist Shalom Schwartz (Schwartz & Bardi 2001; Schwartz 1999; Schwartz 1992) and the dimensions from Trompenaars and Hampden-Turner (2012, first published in 1993). However, despite the great variety of dimensions, the majority of them can be traced back to the early models such as Hofstede's and none of them could be claimed to capture every aspect of culture (Taras et al. 2009). On the other hand, the popularity of Hofstede's dimensions is unquestionable (Baskerville 2003; Redding 1994). It has been extensively used in empirical research and is the dominant explanations of interaction between national cultures (Williamson 2002). It is sound to take them as a main reference and also as a mechanism for describing and understanding cultural diversity that was observed in this research.

2.3.2.3 Hall's context dimension

In addition to Hofstede's paradigm, Anthropologist Edward Hall's (1989) cultural dimension suggested categorizing national cultures into high- and low-context. Hall (1989) developed a theoretical model of cultural variability based on information processing, time orientation and the interaction patterns used by particular cultures (Korac-Kakabadse et al. 2001). The context dimension from his model is one of the most influential dimensions in culture study. Hall (1989) defined context as the 'information that surrounds an event'. He argues that the context that surrounds information is critical to its meaning, and therefore relevant information existing in any interaction must be specified. According to Hall, in low-context cultures, information is largely conveyed by verbal content whereas in high- context cultures the communication relies relatively more heavily on non-verbal languages. In the high-context cultures, the outside environment is found to be much more important than the inside settings. There are many secrets concealed in interpersonal relationships, and meanings are preferably conveyed indirectly. Therefore, High-context communication has been identified as being indirect, ambiguous, maintaining harmony, reserved, and understated (Gudykunst et al. 1996). On the contrary, in a low-context system, low levels of programmed information are used to provide context; therefore, a large amount of explicit information must be present to specify meaning and has

to be identified as direct/explicit, precise, dramatic, open, and based on feeling or true intentions (Gudykunst et al. 1996).

2.3.3 Differences between the UK and China based on cultural dimensions

In Hofstede's (2010) research, he also gave the relative index values of each cultural dimension of the countries studied. Table 2.2 shows the values of the UK and China in each dimension.

Table 2.2 Index Values of Hofstede's cultural dimensions of the UK and China

Cultural Dimension		RANK	INDEX
Power Distance (for 76 Countries and Regions Based on Three Items in the IBM Database Plus Extensions)	UK	65-67	35
	China	12-14	80
Masculinity (for 76 Countries and Regions Based on Factors Scores from 14 Items in the IBM Database Plus Extensions)	UK	11-13	66
	China	11-13	66
Individualism (for 76 Countries and Regions Based on Factor Scores from 14 Items in the IBM Database Plus Extensions)	UK	3	89
	China	58-63	20
Uncertainty Avoidance (for 76 Countries and Regions Based on Three Items in the IBM Database Plus Extensions)	UK	68-69	35
	China	70-71	30
Long-Term Orientation (for 93 Countries and Regions Based on Factor Scores from Three Items in the world Valued Survey)	UK	40-41	51
	China	4	87
Indulgence Versus Restraint (for 93 Countries and Regions Based on Factor Scores from Three Items in the world Valued Survey)	UK	14	69
	China	75	24

The table shows that the two countries have close performance in two dimensions, which are the **Masculinity** and **Uncertainty Avoidance**. The **Masculinity** index values for the two countries are relatively high and in the top third of the 76 countries and regions studied. It indicates that there are quite distinct roles of the two genders in the UK and China, in which men are supposed to be more masculine and women are supposed to be more feminine. The relatively low **Uncertainty Avoidance** index values show both the UK and Chinese people tended to be quite tolerant of ambiguous or unknown situations and prefer fewer rules.

However, on the remaining four dimensions, the two countries show noteworthy differences. On the dimension of **Power Distance**, the UK is a country with small

power distance while China is a typical large-power-distance country. The power distance dimension refers to the way society handles inequality and the extent to which members with less power expect and accept equal power distribution. The index values indicated that the Chinese people have much more tolerance of the inequality of power distribution compared to their UK counterparts. The manifestation of power distance could be found in the role pairs of parent-child, teacher-student, and boss-subordinate. For example, according to Hofstede, in China, the educational process is supposed to be teacher centred and the students simply follow the intellectual path that teachers have outlined; whilst in small-power-distance countries as the UK, on the contrary, the educational process is student centred and the students are expected to find their own intellectual path. Similar situations take place in the family and the workplace in the two countries.

For the dimension of **Individualism**, there is also a tremendous difference between the UK and China. Hofstede describes collectivism as "use of the word 'I' is avoided", "conceive of him- or herself as part of 'we'". The 'we' group is considered to be the major source of one's identity and the only secure protection one has against the hardship of life. China is one of the typical collectivist societies and the UK is a typical individual society. This kind of difference is manifested in the family, workplace and other areas of daily life. A common difference in the performance in the workplace between the Collectivist and Individualist society has been illustrated by Christopher Earley (Hofstede et al. 2010, p.120). According to his experiment, the Chinese participants tended to perform best when operating with a group goal and anonymously whilst they performed worst when working individually and with their names signed to their work, compared to their American counterparts. Contrarily, people from individualist society are expected to act according to their own interests and place more value on individual's performance.

The two countries also differ on the dimension of **Long-Term Orientation**. According to the index value, China is extremely long-term orientated, which is ranked in fourth place of all the 93 countries investigated. Hofstede attributes the

long-term orientation nature of Chinese society to the teachings of Confucius and concludes that in Eastern Asian thinking the search for virtue is key whilst in Western thinking Virtue is secondary to Truth which leads to the short-term orientation nature. The former values learning, honesty, adaptiveness, accountability and self-discipline and the latter values freedom, rights, achievement and thinking for oneself. According to Hofstede et al. (2010), this dimension is closely related to the values of Confucian teaching and China is a typical nation with long-term orientation as a consequence of the long history of the teachings from Confucius. Studies have shown that in long-term orientated societies like China, students tend to attribute success to effort and to attribute failure to a lack of it. In other words, at school Chinese students are supposed to work harder than their UK counterparts. Some other key differences were identified by Hofstede, such as short-term orientation societies tend to be proud of their own country while long-term orientation societies tend to learn from other countries. This type of difference was taken as the main reason for the fast economic growth of some of the Five Dragons (Taiwan, South Korea, Singapore, Hong Kong and Japan) in Asia after World War Two and for China since 1990s.

Another cultural dimension to distinguish the two countries is **Indulgence Versus Restraint,** which is also a relatively new dimension from Hofstede. The index values show that the UK is an indulgent society and China is a restrained society. This dimension is related to the nature of subjective well-being. Some typical features of the two kinds of societies are listed as follows: for indulgent societies, the society is supposed to be loose and there are a higher percentage of very happy people. People tend to have positive attitudes, value leisure and having friends. Whilst for restrained societies, situations are more on the other side: tight society, less very happy people, lower importance of leisure and having friends and high importance in thrift and moral discipline, etc.

Additionally, according to Hall's cultural dimension of **high- and low-context**, the UK and China are also quite different from each other. China is one of the typical examples of culture with high-context where communication is supposed to be indirect, ambiguous, maintaining harmony, reserved, and understated

(Gudykunst et al. 1996) and the outside environment is found to be much more important than the inside settings. In China, people are deeply involved with others therefore subtle messages with deep meaning flow freely. In contrast, the UK epitomizes the low-context cultures where meanings in messages are more direct, clearly stated, leaving nothing implied (Morden 1999; Rodrigues 1998). The interpersonal communications in the UK are largely dependent on information being direct/explicit, precise, dramatic, open, and are based on feelings or true intentions (Gudykunst et al. 1996). It is not difficult to see that the high- and low-context nature is highly correlated to the dimension of **Individualism.** In an individualistic society as in the UK, communication has a high potential to be low-context as the involvement with people is not deep, and vice versa in China. Other related studies have also revealed other attributes of high- and low-context culture in organisational setting, such as individuals from low-context cultures tended to use a competitive style, whereas individuals from high-context cultures tended to use a compromising style (Shockley-Zalabak & Morley 1986). Thus, it is clear that China and UK have many cultural differences, which are likely to manifest in the study of design, and these countries are therefore suitable comparators in the context of this research.

2.3.4 Cognitive differences between the UK and China

As Nisbett et al. (2001) asserted, cultural differences affect not only people's beliefs about the world but also the ways by which they know the world. Research has been conducted by a culturally oriented psychologists to explore the mutual relationship between culture and the mind (Markus & Kitayama 1991; Nisbett et al. 2001; Chiu 1972; Ji et al. 2000). Ishii (2013) suggested in his paper a relation of interconnection among views of self, communication practices, and modes of thought. According to many researchers, self is considered as independent in Western cultural contexts but interdependent in Eastern Asian cultural contexts (Hofstede, 2001; Markus & Kitayama, 1991). The differences in self-perception leads to differences in communication practices, which could be reflected in Hall's (1989) high and low- context dimension. The low-context feature in Western culture and high-context in Eastern Asia in communication

practice, then lead to cultural differences in ways of understanding and thinking about the world (Ishii 2013). This section introduces the main findings in comparing the cognitive differences between Chinese (representative of East/eastern Asian) and the UK (representative of West/ European – American) culture.

2.3.4.1 Analytic vs. Holistic

Nisbett et al. (2001) studied the cultures of ancient China and Greece and asserted that with the metaphysical beliefs maintained, the relevant cognitive differences might also be found in contemporary societies. One of the differences they proposed was from the perspective of attention range in terms of perceiving the object and the field, in which they specified as that Westerners tend to see parts of the objects whereas the Chinese tend to see the whole and easily see relationships between the objects in the field. These differences further drive Westerners to an analytic mode of thought and the Chinese a holistic one. The former tend to think analytically and pay more attention to the focal object and its features and the latter tend to think holistically and emphasise more on context and relationships between the focal object and its context, namely the field that is the background aspects of the environment (Nisbett et al. 2001). The analytic vs. holistic attributes among Eastern Asian and Western cultures has been explored and confirmed by numerous researchers (Ji & Yap 2016; Imai et al. 2016; Ishii 2013; Gelfand & Kashima 2015). In her investigation with Indian and American participants, Miller (1984) found that Americans tended to explain another person's behaviour predominantly in terms of traits whereas Indians interpret behaviours based on social roles, obligations, the physical environment and other contextual factors. Ji et al. (2004) found in their study that European Americans tended to judge based on shared features and categories and Chinese were more likely to judge on contextual relationships. Imai et al. (2016) found these attributes differentiate the Chinese and American's behaviour in using Facebook, with the Chinese showing the potential of deemphasizing their faces and highlighting the surrounding context in their pictures.

2.3.4.2 Functional vs. Thematic

This cognitive difference was derived from the Analytic vs. Holistic one. Chiu (1972), in her study with a group of North American and Chinese children, found that the former tended to classify stimuli based on functions for inferences made out of stimuli that are grouped together whereas the latter ones tended to classify based on interrelationships and thematic relationships. The finding has also been confirmed by Choong & Salvendy (1999), who found in their study that the provision of the functional structure of a computer system helped the American participants reduce the error rate whilst the provision of a thematic structure reduced the time and error rate of the Chinese participants. The functional cognitive style of Westerners tends to be "analytic, abstract, and imaginative or beyond the realm of the immediately apprehended". The thematic style of Chinese people tends to be "synthetic, concrete, and remain on the periphery of the visible world" (Choong & Salvendy 1999).

2.3.4.3 Monochronic-time vs. Polychronic-time

In his book, Hall (1989) also suggested a cultural feature in people's perception of time and space: Monochronic time (M-time) vs. Polychronic time (P-time). M-time emphasizes schedules, segmentation, and promptness whereas P-time is featured as several things happening simultaneously. Although Hall only used the Middle East and Latin America as typical examples of P-time culture, following research has addressed the P-time nature of Chinese culture (Marcus 2003; Everdingen & Waarts 2003; Morden 1999; Xu-Priour et al. 2014), especially compared to the UK. According to Hall's observations, M-time orientated people are task-oriented, emphasise promptness and conscious of privacy, stick to schedules and are accustomed to short-term relationships with other people. On the other hand, P-time orientated people have high potential in changing schedules, focus on relationships instead of task and privacy, and value long-term relationships with other people (Bluedorn et al. 1992). It is noticeable that these differences could be traced to the cultural dimensions such as short-term vs. long-term orientation and individualism vs. collectivism.

2.4 Relationship between design and culture

The relationship between culture and design can be found in some definitions of culture. Kroeber and Kluckhohn (1952 cited by Razzaghi et al., 2009) describe culture as something that "consists of pattern, explicit and implicit, of and for, behaviour acquired and transmitted by symbols, constituting the distinctive achievement of human groups, including their embodiments in artefacts". This kind of relationship was confirmed and illustrated by the 'Onion' model from Hofstede (2010), which divides the concept of culture into four layers: symbols, heroes, rituals, and values (Figure 2.8). The symbols are "words, gestures, pictures, or objects that carry a particular meaning", in which design is included. Design is 'visible'; it carries a special meaning and is a manifestation of a group's culture. The relationship between culture and design could be perceived from two perspectives: On the one hand, also as Brett et al. (1997) proposed, products or artefacts, which are the outcome of a design process, can be considered as one medium through which culture is manifested and embodied; on the other hand, culture provides an appropriate background to understand the design from the specific culture.

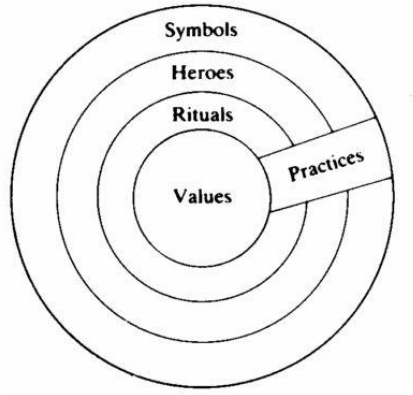


Figure 2.8 The "Onion": manifestations of culture at different levels of depth

The significance of the role of culture in design is undeniable. It is not surprising that the International Council of Societies of Industrial Design defines design as a "crucial factor of cultural and economic exchange". According to many researchers (Baxter, 1999; Desouza and Dejean, 1999; Moalosi, 2007), users do not only possess physical and biological attributes, but also socio-cultural

attributes. The user experience, as mentioned in 2.1.4, relies heavily on the social and cultural aspects. Product acceptance and user's satisfaction is not only derived from the provided functionality, usability, but also the interaction, experiences and pleasurability (Jordan 2000), which could be greatly facilitated by the integration of cultural consideration. This kind of interpretation derived one of the aims of this research, namely the investigation of the cultural difference from the perspective of design outcomes, especially from the way the end users interpret the design outcomes.

The impacts of culture are also not only maintained on the artefacts or products, but also on the way they are developed, namely the design process. Hofstede & Hofstede (2002) declared that each culture evolved its own answer to its problem. Though they did not illuminate it, this statement involves two perspectives of how each culture differs -- the way they evolve the answer and the specification of the answer. Gaver et al. (1999) asserted that cultural values provide designers with a rich and varied set of material that could be used to inspire the design concepts. Razzaghi et al. (2009) also pointed out that culture notably influenced in the way designers structure a product in the early stage of concept development. Their study confirmed that the differences in the way of developing design concepts have links to differences in culture. Furthermore, the cognitive differences which were introduced in Section 2.3.4 also indicate the possibility of cognitive differences in the design process between different cultures. Therefore this research also aims to explore the cultural differences from the perspective of design process, especially from the point of view of design cognition.

2.4.1 Existing research investigating the relationship between design and culture

Purcell & Gero (1998) described design as one of the significant intellectual activities because of its complexity and the effects its results have on society. The complexity refers to the design process and its results are the design outcomes. The relationship between design and culture discussed above reveals two main

perspectives, namely the relationship between culture and design outcome, and relationship between culture and design process. This section reviews the existing research that addresses the issues from these two perspectives.

2.4.1.1 Culture and design outcome

There are large numbers of areas of research that have explored the relationship between culture and design outcomes. Human Computer Interaction is one of the most explored areas on this topic: Marcus and Gould (2000) introduced Hofstede's culture dimensions and discussed how they might affect **web user-interface design** using websites from different cultural backgrounds. Snelders et al. (2011) performed two studies to investigate the cultural adaption of web design of small and medium sized ICT companies in Germany and Spain and demonstrated that the cultural adaption of the **web design** had effective influence on the industry styles. The role of culture in other specific design areas has also been explored. Bluntzer et al. (2014) analysed a group of French and German cars to investigate the relationship between **car style** and cultural preferences. They found that French cars tended to have some specific styling lines and a French style identity is implicitly embedded in the car's design compared to their German counterparts. Seva & Helander (2009) studied the cultural difference among users from Singapore and the Philippines on their emotional responses towards **cellular phone** attributes. They found that Singaporeans value functional attributes more, whilst the Filipinos focused more on aesthetics.

There is research that explores the cultural aspects of design from the perspectives of Chinese users, although the majority of research was focused on the interface design: Marcus (2003) also discussed a possible cultural influence on **user-interface design** from the perspective of Chinese culture. He suggested some implications of typical Chinese characteristics compared to Western cultures: **metaphors** (Chinese people emphasise the concepts of people, relationships and wisdom, whereas the Westerns emphasis is on applications and documents), mental models (holistic vs. analytic), website navigation (Chinese prefer the provision of many major destinations simultaneously instead of

checking menu selection one at a time), interaction (polychromic vs. monochronic time) and appearance & presentation (inherent attributes in Chinese characters: derived from pictographic signs and contain complex marks within a square format). Evers & Day (1997) examined user's cultural preferences on **interface design** by interviewing 206 international students (the majority from Indonesia and China) plus a control group of 38 Australian students. The results confirmed that the cultural preferences in design affect interface acceptance and the way of influence leading from preference to attitude and behaviour varies among cultures. According to their results, the Chinese participants tended to find usefulness a more discernible variable compared to the Indonesians and their preferences in the interface design directly influence their attitudes of satisfaction. Shen et al. (2006) redesigned **computer interface** using a Chinese style 'garden' metaphor to investigate the influence of culture-centre design on the performance of Chinese users. However, their results showed an equal performance between the Chinese and international users and they concluded that the results could be influences by regional variations, more countries represented and a higher age group of users. Choong & Salvendy (1998) conducted a study to investigate the cultural differences between the American and Chinese users on the use of icon display on a **computer interface**. They found that the American users showed better performance with alphanumeric and combined (alphanumeric + pictorial) modes whereas the Chinese users shows advantages to pictorial and combined modes.

2.4.1.2 Culture and design process

Compared to the former category of research, the research that addresses the relationship between culture and design process is quite limited. Razzaghi et al. (2009) conducted comparisons between Australian and Iranian students' design concepts to probe **cultural patterns in product design ideas**. From the detailed content analysis on the sketches from the designers they found ten patterns among the concepts generated by the student designers from the same culture, for example, there was a pattern in product life in which the Iranian participants paid much more attention to the safeguard of the product from uncertain

circumstances. They also analysed the possible cultural influences on the patterns using the cultural models from Hofstede et al. (2010) and Hall (1989). Choe (2004) conducted an empirical study to investigate the **cultural differences in the amount of information** in the design of information systems, using samples from Australian and Korea. He found that Korean firms tended to provide more flexibility performance information; whilst Australian firms provided more quality performance and traditional cost control information, which he attributed to the individualism culture of Australian. In his PhD research, Moalosi (2007) investigated the **relationship between culture and human-centred design** based on Botswana. His research focused on the integration of culture factors such as local thought, content and solutions to the design practice, based on which he developed a design model to assist designers to integrate culture in their practice.

The research from Chueng-Nainby (2010) was the only relevant study that addressed the relationship between culture and design process from a cross-cultural perspective. She conducted a series of ethnographic studies to describe **concept negotiation during early design collaboration** between Western and Chinese designers. Her investigation covers numerous differences that exist in the design behaviours from the Western and Chinese designers based on her observations in a design agency. She also found that in creative processes Chinese designers tended to ideate and western designers tended to conceptualise. Her research focused more on the perspective of communication between the designers from different cultural backgrounds in a collaborative design situation.

2.5 Conclusion

The overall aim of this chapter was to provide a theoretical perspective that can be used to inform the research process. It reviews the concepts of design and a brief history of design methodology developed on prescriptivism and descriptivism, which give the perspectives of understanding design as problem-solving and reflective practice respectively. Models that are based on these two

theories were also introduced, which were used in different studies in this research and presented in the following chapters. The concept of culture is also explored in this chapter, which was mainly through the cultural dimensions from Hofstede (2010) and Hall (1989). The further interpretation of the cultural dimensions showed that the UK is an individual and indulgent society with low power distance, short-term orientation and low context environment, whereas China, on the other hand, is a collective and restrained society with high power distance, long-term orientation and a high context environment. These differences were manifested in different aspects of the daily life of people from each country, especially in the aspect of thought systems. The UK people tend to show an analytic cognitive style and were supposed to be abstract, imaginative and focused more on parts and functional aspects. They also tend to have a Monochronic perception of time and space. Chinese people were assumed to have a holistic cognitive style, with which they tend to see the whole instead of parts and focused on thematic relationships. They had a Polychronic perception of time and space. All these differences are supposed to have a vital impact on the performances in design activities. The four studies in the research of this thesis were developed to explore the differences based on the consideration of the revealed cultural differences. The following chapter explains the methodology used within this research to explore the role of culture from the perspective of design outcome and design process respectively.

3 GENERAL METHODOLOGY

3.1 Chapter overview

This chapter presents a description of the methodology used in the research. Along with the overall research structure, the methodology is presented in two phases: the methodology used in exploring the role of culture in design outcome and the methodology used in exploring the role of culture in design process.

3.2 Introduction

As Cross (2013) pointed out, design knowledge resides firstly in people, not only designers, but also in every individual. Due to the different people it refers to, Cross also concluded that design research is mainly conducted from two perspectives: design process – which investigates the design activity from the point of view of designers, i.e. how people design, and how design methodology is used to aid the design process; and design outcome – which investigate the design from the point of view of end users, it mainly studies the forms, materials and finishes which embodies design attributes. In this thesis, the role of culture in product design is also explored from these two perspectives. The previous chapter presents the literature which provides a theoretical perspective that can be used to understand design activities from the two perspectives. This chapter discusses the general methodology that may be sued to investigate design from the two perspectives and also their applicability in this thesis.

3.3 Exploring the role of culture in design outcome

3.3.1 Subjective evaluation vs. objective evaluation

According to the literature, in the cross-cultural research area, there are mainly two popular ways of evaluation, namely subjective and objective evaluation (Oyugi et al. 2008; Herman 1996; Vatrapu & Perez-Quinones 2004). Objective evaluation typically refers to quantitative performance measures, whereas subjective evaluation is normally derived user surveys via methods such as

questionnaires and interviews (Herman 1996). The debate over objective and subjective measurement has been an issue since the very beginning of the discipline of ergonomics and human factors. Although early reviews always judge subjective measurements as biased when the results differ from the ones from objective measurements, this kind of assumptions are not taken as granted by researchers anymore. Actually, the even the distinction between the two is not always as obvious as it seems to be. As Wilson & Sharples (2015, Chap. 1) pointed out, regarding the actual selection of measures, criterion levels and methods, some forms of objective measurement may contain many elements of possible observer bias and of subjectivity. In this thesis, objective evaluation of design is defined as the direct measure of countable behaviours or reactions which are normally related to the aspect of usability. Subjective evaluation here refers to interpretation from the participants about the design and could be used for wider ranges of aspects such as usability, aesthetics, creativity, etc. In design evaluation, it does not only involve the complexity of human beings, i.e. the designers – their complex intellectual activities, but also the user's evaluation on the outcome of such complex activities. In this context, subjective measures are extremely valuable in capturing user's perceptions, which may not only affect their attitudes but also their selected behaviours and interactions (Wilson & Sharples 2015, Chap. 1) and this is the essence of involving users in the cross-cultural studies.

3.3.2 Exploring cultural differences with users

Subjective evaluations in existing research were mainly conduct in two ways: (1). design evaluation with the researchers / experts (Marcus & Gould 2000; Bluntzer et al. 2014); and (2) design evaluation with users (Bluntzer et al. 2014; Evers & Day 1997; Shen et al. 2006; Choong & Salvendy 1998; Choong & Salvendy 1999). The first relies on the expertise of the experienced professionals and existing knowledge of the relevant evaluation. The results of the evaluation would normally be examined using certain cultural dimensions to explore the underlying cultural reasons. For example, in their study, Marcus & Gould (2000) compared a group of website design using potential different characteristics of

user-interface and Web design that were developed based on Hofstede's (2010, cited in their paper 1st ed 1997) cultural dimensions. One of the drawbacks of this approach is potential bias, either from the researchers / experts or from the existing knowledge which is normally the findings of former research. The involvement of users in design evaluation is a commonly used method in crossed cultural studies, especially the areas such as marketing, Human Computer Interaction and design etc. Use the users as the evaluator can avoid the bias from the researcher and also existing knowledge; furthermore, the evaluation of users from the relevant cultures carry the information that can is commonly explored in cross-cultural studies. Also, the role of the user in the concept of experience design, as reviewed in Section 2.2.5, make it a good means for design evaluation in design studies.

Interview and questionnaire

Kuniavsky (2003) defined an **interview** as a method of asking users about their experiences and it differs from interviews normally carried out by an investigative journalist because of its nondirected nature. However, as Kuniavsky (2003) also indicated, it is not easy to avoid directed questioning, which requires from the interviewer a constant vigilance and a strong desire to elicit the interviewee's real thoughts. The interviewer needs to stay neutral throughout the whole process and also leave aside their own knowledge and feelings. The questions need to be composed carefully to avoid the potential for bias.

A questionnaire is a commonly used technique in studies of users and technology (Day & Evers 1999). It can include a set of structured questions asking users to describe themselves, their needs, interests and preferences (Kuniavsky 2012; Sun 2009). As Day & Evers (1999) asserted, a questionnaire is especially useful in offering the quantity of responses necessary to achieve statistical significance, as the more personalised and interactive methods of data collection can only achieve relatively small numbers of subjects. It is a relatively low cost and easy way to collect data, but also needs careful design and construction to fit specific subjects.

3.4 Exploring the role of culture in the design process

3.4.1 Methods for studying the cognitive design process

The complexity of the design process has been confirmed by many researchers (Gero & McNeill, 1998), however, it is still meaningful and useful to study it, because "understanding the design process is important to its improvement" (Whitney 1990). Designing is the activity carried out by designers; therefore the study of design is to investigate how designers think in the design process. As Chueng-Nainby (2010) asserted in her study, research methodology suitable for study of design activities in a cross-cultural setting is itself a topic worthy of research and the ideal one should be both explorative and holistic. Research in the field of design cognition has been conducted for more than half a century, since the pioneering research from Marples on engineering designers in 1960. In 2007, Cross wrote a concluding article to review the previous forty years history of design research, in which he concluded that there was a transformation between two generations of design methods in the 1970s – from the first generation that were based on the application of systematic, rational, 'scientific' methods which emphasise the "omnipotence of the designer" to the second generation that focused on the "recognition of satisfactory or appropriate solutions". Various methods have been established to investigate the nature of design thinking since the 1960s. Cross (1999, 2001) in his series of design research, summarised the methods that had been used, which are listed as follows:

Interviews. The interview used in studies of the design process is normally unstructured, which is to obtain the thoughts from the designer on the process and procedures they use. It needs to be developed based on the answers from the designer about the specific design activity.

Observations and case studies. These methods could only be used on one particular design project at a time. The observers record the project contemporaneously or post-hoc and different types of observation methods can be applied.

Protocol studies. This method is the most typical method for analysing design cognition and is always associated with another technique – the 'thinking-aloud' technique (Suwa & Tversky 1997; Sharp et al. 2013; Tang et al. 2011). It is normally conducted by videotaping and/or audiotaping the whole design process which is then analysed later by the researcher.

Reflection and theorising. One of the basic theories of these methods is descriptivism design, of which Schön (1991) is one of the main scholars. It is intended to investigate the implicit practice in the "artic, intuitive processes" from the designers when they are in situations of "uncertainty, instability, uniqueness and value conflict" (Schön 1991).

As Cross (1999) declares himself, these methods are "adopted and adapted" to investigate design activity. The methods above are presented in a descriptive way rather than a defined way. Firstly, they are not intended to be distinct or exclusive from each other. For example, in a case study, the method of protocol study could be applied and a protocol study could also be applied to reflection studies. Also, the conducting of these methods does not need to strictly follow the descriptions. Take the protocol study from Suwa & Tversky (1997) for example, with the consideration of the possible interference to the design process of using thinking-aloud, they divided the study into two parts, a design task and a report task – a post-hoc 'thinking aloud'.

3.5 The context of cross-culture

When measuring objects that are as vague as culture, things seem to get complicated and difficult to control. As Vatrapu & Perez-Quinones (2004) asserted, you can never be too careful to measure it in order to study its effect. The effect of culture on the use of methods in cross-cultural studies has been identified by many researchers (Vatrapu & Perez-Quinones 2004; Day & Evers 1999; Clemmensen 2012; Herman 1996; Heine et al. 2002; Oyugi et al. 2008; Yeo 1998; Clemmensen et al. 2007; Shi 2008). Cultural groups respond differently to different methods of data collection. For example, according to the findings from Shi (2008) and Clemmensen et al.(2007), the holistic way of thinking of Chinese

people is not as readily verbalized as analytical thought, and therefore Chinese users are not suitable for thinking-aloud tests as they would find it difficult to put their thoughts into spoken words. In their study about usability evaluation, Vatrapu & Perez-Quinones (2004) also found that participants tended to perform differently according to the interviewer's cultural background: with an interviewer from a similar socio-cultural background, participants tended to point out more usability problems; whereas with an interviewer with a different socio-cultural background, they tended to give more positive comments and fewer negative comments. Therefore in cross-culture studies, there should be paid to the adoption of research methods.

In the use of interview, Kuniavsky (2003) suggested in his book that the questions should be open-ended so as to keep the process of eliciting information non-directed. However, when it comes to the realm of culture, researchers have different opinions. Day & Evers (1999) encouraged researchers to keep open-ended questions to a minimum in instruments for multicultural data collection. Vatrapu & Perez-Quinones (2004) also argued that a structured approach provides more reliable and quantifiable data and can be designed rigorously to avoid bias from the phrasing of the questions. In the design of a questionnaire in cross-cultural studies, Day & Evers (Day & Evers 1999) suggested that no questions should be taken directly from another study due to the dynamic cultural milieu that relate to different elements such as language, the degree to which the specific topic conform to the cultural context and culturally specific expectations toward the topic, etc. (Day 1996). They also suggested some other techniques such as using graphics to avoid text-heavy instrument and also misunderstanding due to language comprehension problems.

3.6 Methods used in this research

This research investigates design activities from the perspectives of design outcome and design process in the context of cross-culture. It involves literature research and empirical studies. As Chueng-Nainby (2010) asserted in her study, research methodology suitable for study of design activities in a cross-cultural

setting is itself a topic worthy of research and the ideal one should be both explorative and holistic. A diagram is built up to present the research method in a holistic way. The diagram indicates the structure of which the research was developed on.

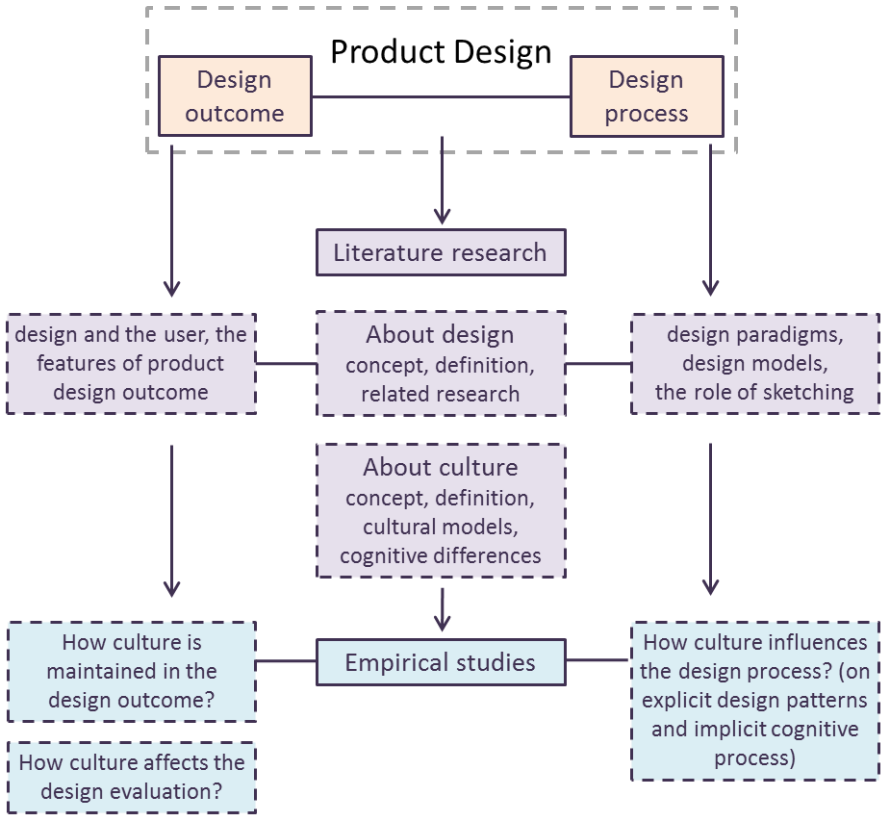


Figure 3.1 Research diagram for cultural differences in product design

3.6.1 Methods applied to investigate design outcomes in the context of cross-culture

In this research, to explore the role of culture in design outcome refers to two perspectives: 1. How culture is maintained in the design outcome, namely the cultural differences in the features of design outcome; 2. How culture affects the general users' evaluation of the design outcome. The first refers to the attributes that are embodied in the design outcomes and the latter refers to the criteria used in relevant evaluation. Design outcomes, which were the results of design processes, were normally presented in the format of sketches or pictures, e.g. the final designs from the students. Instead of being tested objectively, this kind

of format is more applicable for subjective measurements and therefore subjective evaluation is the main method used here.

3.6.1.1 Methods applied in Study 1 – understanding the role of culture in design outcomes

The first study in this research was intended to probe whether differences exist in the features of design outcomes and in the evaluation of design outcomes.

To investigate the potential differences, interviews with participants from each culture were chosen to gain an initial understanding of the role of culture from the perspective of design outcome. The participants were taken as potential end-users, rather than experts in design evaluation, to evaluate design works from design students from both of the two cultures. In order to collect subjective data in an objective manner to eliminate the assumed 'inherent' inaccuracy to a minimum level (Wilson & Sharples 2015, Chap. 1), the technique of repertory grid was applied to structure the interview procedure.

The repertory grid technique was initially developed by psychologist George Kelly (1955) to help his clients analyse their own interpersonal relationships. It is based on his explicit theory of human understanding, known as the Personal Construct Theory, with a central assumption that people construct their own world by using a finite number of dichotomous constructs rather than absolutes. The aim of developing this method was "to get beyond the words" – it promises accurate measurement of subtle perceptions (Easterby-Smith 1981). It is a technique that provides structure to an interview, "without at the same time imposing predetermined destination characteristics that are not relevant to a respondent or respondent group and are potentially ambiguous" (Hankinson 2006). This semi-structured feature of repertory grid technique provided an ingenious solution to the dilemma of whether structured or open-ended questions should be adopted as the main body of the interview process (Hassenzahl & Wessler 2000). The application of repertory grid technique to the method of interview helps the researcher get in-depth information from the participant's individual

perception on the design attributes and also their evaluation criteria, but at the same time minimises any potential bias from the researcher.

3.6.1.2 Methods applied in Study 2 – validate the results of Study 1 with a larger sample size

The second study was designed to validate the differences in design evaluation found in Study 1 with a large sample size. The methods of online questionnaire were chosen here as it is an easy and cheap way of achieving the quantity of responses necessary to achieve statistical significance (Day & Evers 1999). Furthermore, due to the nature of repertory grid, the differences found in design attributes in Study 1 were drawn from spontaneous answers from the participants; the form of questionnaire used in Study 2 allowed the researchers to investigate some specific aspects into greater details.

3.6.2 Methods applied to investigate design outcomes in the context of cross-culture

The overall aim of the studies with designers, either student designers or professional designers, was to investigate the role of culture in design processes. The design processes here were investigated from the aspects, i.e. the explicit design patterns and the implicit cognitive processes. The design patterns here refer to the contents that are presented in design representations, such as sketches, pictures and texts. The cognitive processes refer to the invisible thinking processes that take place in the designer's mind on which the design processes are structured. As introduced in the literature review, there are two main streams in the history of design methodology, i.e. the prescriptivism and the descriptivism. In this research, both of the two types of paradigms were applied to interpret the design processes. Prescriptivism takes design as a process of problem solving and therefore is normally presented in rigid paradigms and is helpful in understanding design in a logical way. This kind of paradigm was used when investigating the design patterns that shown in design processes. Descriptivism describes design as a reflective process and therefore is

more close to the real situation that actually takes place in the design activities. The relevant paradigm was used to explore the cognitive process in design.

3.6.2.1 Methods applied in Study 3 – comparing the design process of student designers

In Study 3, due to ethical and practical reasons (as it would need to set several cameras in the design studio) it was not applicable to use traditional protocol study to investigate the design processes of design students directly. Therefore, a reflective method was used to study the cognitive processes shown in design submissions in a post-hoc way. The reflective method was developed based on the theory of descriptivism, which focused more on the organic links between design process, task and designer when the designer is structuring and solving the design problem, rather than the logical components of a design process (Dorst 1997). This nature of descriptivism design paradigm makes it possible to use it to interpret the design cognitive in a post-hoc way, with the deficiency of real-time data on the design process.

Furthermore, to observe the design activities requires an awareness of both 1) explicit and implicit cues, 2) social issues and cognitive factors (Chueng-Nainby 2010). There is inevitably information lost in the collected design submissions, e.g. the social aspects such as the interaction of the students in the design studio; and the cognitive aspect such as the cognition experience of the students when they were sketching. The method of ethnographic observation was applied in the design studio where the students did most of their design activities to fill the void.

In order to investigate the design pattern, i.e. the contents that are presented in design representations, a content analysis use the technique of semantic word cloud analysis was also use in this study. The method of word cloud on text has been used a lot as a tool for abstracting, visualizing and comparing data (Heimerl et al. 2014; McNaught & Lam 2010; Stasko et al. 2008). However, some researchers have complained about the missing analysis on the semantic relationships of the words with this technique (Wang et al. 2014; Barth et al.

2014). In this study, the semantic word cloud analysis online system from Barth et al. (2014) was used to address this issue.

3.6.2.2 Methods applied in Study 4 – comparing the design process of professional designers

Study 4 was set to validate the findings of Study 3 with practitioner designers from the UK and China. The method used here was a protocol study. Instead of looking at the design process from a reflective post-hoc way, in this study the design process was observed and analysed directly - the recruited designers were asked to finish a design task in a set time and the whole process was videotaped for post-hoc analysis. According to Shi (2008) and Clemmensen et al.(2007), Chinese people have difficulty in putting their thoughts into spoken words during protocol studies. Also, protocol analysis has been criticised by researchers for its limitations in capturing non-verbal thought processes, which is usually a crucial part of the design cognition (Cross 2004). Therefore, the protocol study used here did not use the think-aloud method simultaneously; instead an interview was conducted after the design task to elicit the information in the designer's mind when they were doing each sketch. The interview was semi-structured. The main part was to clarify the information that was presented in the sketches and the information that was in the mind of the designers but not presented in the sketches, during the design process. Also other questions such as the background knowledge of this task, the sources of inspiration, time pressures etc. were asked to explore further information.

Also, a coding analysis was used in this study to capture the design patterns shown in the design representations. The coding system was developed based a prescriptive design paradigm, which decomposes the design process into logical components therefore make it easier to be compared according to the designers' cultural backgrounds.

3.6.3 Challenges anticipated and method justification

During the development of the studies, a series of challenges were expected dependent on the different stages.

In Study 1, which was about the evaluation of the students' design work, there was a concern that no difference would be found in the designs. One reason for this concern was that, the designers, who were first year students enrolled in the Product Design and Manufacture (PDM) course, were educated on the same courses using the same material. Another reason was the consideration of the major background of globalisation, the young Chinese generation were inevitably westernised to a certain extent, which could be observed from their daily dress style, their form of entertainment and consumption etc. Therefore it was difficult to imagine that any significant difference would show up in these groups of design freshmen. Also, potential bias from the researcher or the relevant literature was also concerned when comparing design evaluation. These concerns were addressed by the introduction of repertory grid as the main technique used in the interview. Repertory grid is a technique that promises accurate measure of subtle perceptions but at the same time minimises any potential bias from the researcher as it only involves spontaneous answers from the participants. The use of this technique also made the comparison between the different groups feasible, which eliminated the possibility of individual differences being the main reason for the revealed differences.

The main concern of the study with the student designers was the ethical considerations, as their normal study should not be disturbed by the research activities. Protocol study is a traditional method used to study the design process, as it applies a real-time investigation on the design process which is recorded for further detailed analysis. Due to the ethical considerations, the study with student designers in this research did not use the method of protocol study. Instead a reflection method of studying the design process was developed in a post-hoc way to address such a dilemma. The reflection method was developed with the sacrifice of losing the real-time data of the actual design process; however, due to the nature of descriptivism model, which is developed on the theory of reflective practice (Schön 1991, originally published in 1983) and the notion of situated cognition (Suchman 1987), it reveals the actual cognitive process that take place in the design activities. Additionally, to make up such a

defect, this study also used the method of ethnographic observation to capture the lost information such as the social aspects of the design activities and cognitive aspects of the design process.

3.7 Conclusion

This chapter introduced the research methods that were used in design studies in investigating the design outcomes and design processes, especially the methods used in a cross-cultural context. It also outlined the methods that were used in each study in this research, which were carried out from the perspective of design outcome and design process respectively (see in Figure 3.2). The followings chapters present the studies that were developed on the general methods described here; the specific analyses will be described in the subsequent chapters.

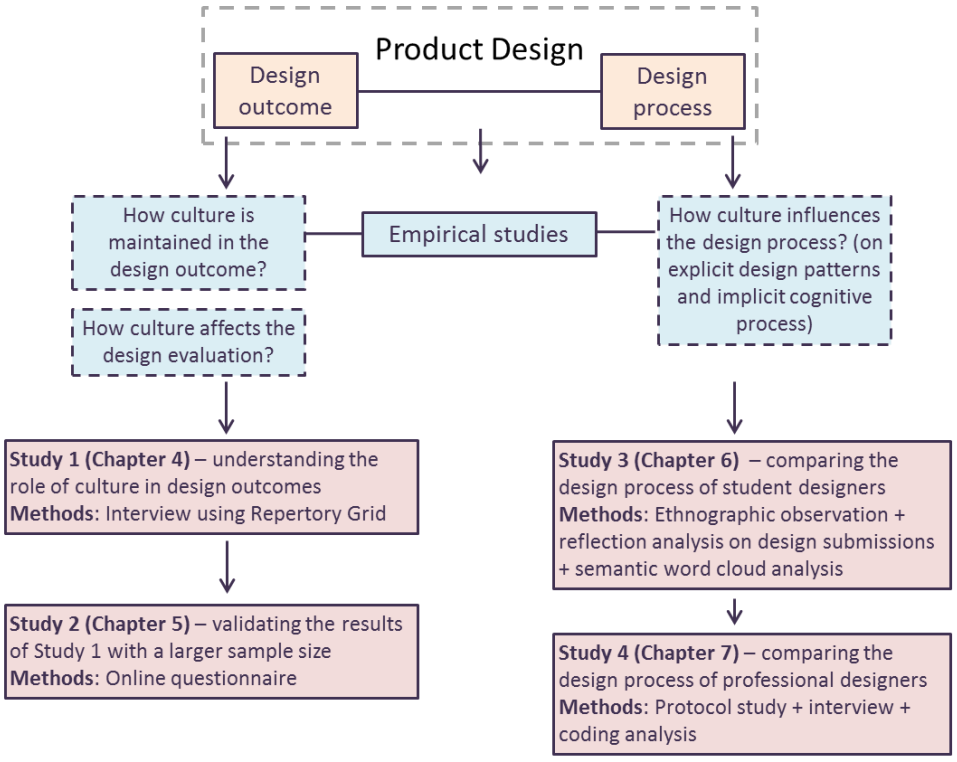


Figure 3.2 Diagram of method methods used in empirical studies

4 CULTURAL DIFFERENCES IN THE DESIGN OUTCOME USING REPERTORY GRID ANALYSIS

4.1 Chapter overview

This chapter presents an exploratory study with the aim to detect the role of culture s in product design in the UK and China from two dimensions: in the attributes of design outcomes and in the evaluation of design outcomes. The study used the method of interview to compare a group of UK and Chinese participants in their evaluation of 18 designs from UK and Chinese student designers. The method of Repertory grid as an interview technique was also introduced.

4.2 Introduction

Two studies were conducted to investigate the cultural differences in the design outcomes. The first is represented in this chapter which was an exploratory study with aim to detect the differences from two dimensions: differences in the features of design outcomes & differences in the evaluation of design outcomes. The second study can be found in Chapter 4, which was designed to validate the differences in design evaluation with large samples and also to explore the judging criteria into further levels.

The cultural dimensions such as the ones introduced in section 2.3 from Hofstede (2010) and others such as Scwhartz's (1992) seven cultural values and Trompenaars & Hampden-Turner's (2012) cultural dimensions are frequently used constructs for measuring culture in the design field. One common characteristic of these cultural constructs is that they all propose cultural values or dimensions that are universal across cultures but with relative dominance of each value type or dimension differing across cultures and therefore can be used to predict attitudes towards external stimuli or behaviours (Tomico et al. 2009). Basically, the use of these cultural constructs in measuring culture differences is through gathering data using questionnaires or interviews. However, Hofstede

(2006) suggested that his cultural dimensions are at a high level of abstraction, far above the respondents' daily concerns. When it comes to domain-specific design choices, it is inevitable that there will be doubt about whether it is too abstract to apply these cultural constructs into the measurement of cultural differences, and also to the fruitfulness and meaningfulness of any results.

4.2.1 The method of repertory grids

As introduced in section 3.6.1.1, the repertory grid is a technique from psychologist George Kelly (1955) that is used to explore individuals' deep personal interpretation of specific subjects but at the meanwhile eliminate potential bias from the researcher. Its applicable subjects could be 'public' constructs such as mathematics or science to very personal ones such as feelings and relationship (Fransella 1977). However, as Jankowicz (2004) pointed out, repertory grid is still a technique "little used beyond its specialist adherents". A small number of applications of repertory grids can be found in areas such as marketing (Pike 2004; Caldwell & Coshall 2002), tourism (Embacher & Buttle 1989; Hankinson 2006; Naoi et al. 2006), management (Caldwell & Coshall 2002; Dick & Jankowicz 2001) and the Information System field (Hunter 1997; Tan & Hunter 2002).

In the area of design studies, based on the theory of experience design presented in section 2.2.5, a well-defined problem is vital to the development of a successful design solution (Lai et al. 2010). The key to a well-defined problem is the efficient interactions with users. The application of repertory grids would help the researchers explore in more depth the users interpretation of any specific area therefore could ultimately enhance the design. However, despite the promising future of repertory grid technique, it is still under used in this area. Fallman and Waterworth (2005) used repertory grids to investigate 18 participants' different styles of interaction with 7 different mobile information technology devices. It focused on user experience and affective evaluation, but not necessarily related to design improvement. Gkouskos, et al. (2014) used repertory grids in the format of an online survey to investigate prominent

dimensions of driver needs. Textual descriptions of five futuristic vehicles were compared by repertory grids to elicit user needs on vehicle design. Hassenzahl & Wessler (2000) used repertory grid technique to gather information about 7 different prototypes from 11 individuals in a hypothesised aim of guiding redesign. They also commented on the advantages and limitations of the application of repertory grid technique. They suggested repertory grid technique is an efficient tool to collect high practical, economic design – relevant information with a wide variety of potential analyses. They also claimed that repertory grid technique is insensitive to good or bad attributes in the artifacts. The high number of useless descriptive constructs (compared to evaluative constructs) and the unclear relations between personal constructs are also questionable using repertory grid technique.

This study proposed a subjective approach to investigate the cultural differences in design outcomes that are developed at an individual level, using repertory grids as a basic technique. When using interviews to measure vague subjects such as culture, it is always debatable whether structured or open-ended questions should be adopted as the main body of the interview process (Day & Evers 1999; Vatrapu & Perez-Quinones 2004). The adoption of the repertory grid technique, a semi-structured interview technique, has provided an ingenious solution to this problem (Hassenzahl & Wessler 2000). As Hankinson (2006) claimed, it provides structure to an interview which makes the process more controllable, but not imposing any predetermined destination characteristics from the researchers which are not relevant to the interviewees. When applying this technique to the exploration of cultural differences contained in design, it takes individuals' perceptions to be a carrier of implicit cultural insights and, therefore, they can be investigated within a specific context through these designs (Tomico et al. 2009). There is little research that has applied repertory grids to the investigation of cultural differences, especially from the perspective of design. Hunter et al. (2000) used it to explore the differences among Canadian and Singaporean participants in their evaluation of information systems. Tomico et.al (2009) used it to examine the differences in Dutch and Japanese designers'

perception of a set of pens. The present study presents the detailed information of applying repertory grids to investigate the differences in design outcomes from two dimensions of the UK and Chinese product design, namely the differences in the features of design outcomes and the differences in the evaluation of design outcomes. It also solved the limitations proposed by Hassenzahl & Wessler (2000) in using repertory grid technique.

4.3 Study set-up

On the UK and Ningbo (China) Campuses of the University of Nottingham, students majored in Product Design and Manufacturing use the same teaching materials and study system. Nine pieces of design work were collected from students in the equivalent year from each campus, to be used as the subjects of comparison in this study (see Figures 1 & 2). The designs were these students' first practice pieces in product design. The task design they had been given was to design a stationery rack for 14 to 18 year olds. At that stage of their course, he sketching and design skills of the students were not sophisticated enough to define them as credible 'design work'. Nevertheless, it was the natural design processes of the two groups of design 'novices' that made them a good choice of samples to compare the differences between UK and Chinese designs. The 18 pieces of design work were numbered from 1 to 18, with numbers 1 to 9 from the UK student designers and numbers 10 to 18 from the Chinese students. This was not revealed to the participants who were to evaluate the designs.

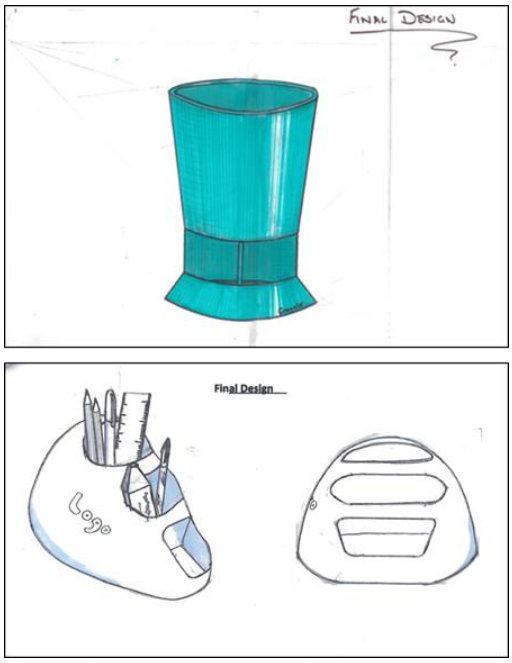


Figure 4.1 Examples of UK students' designs

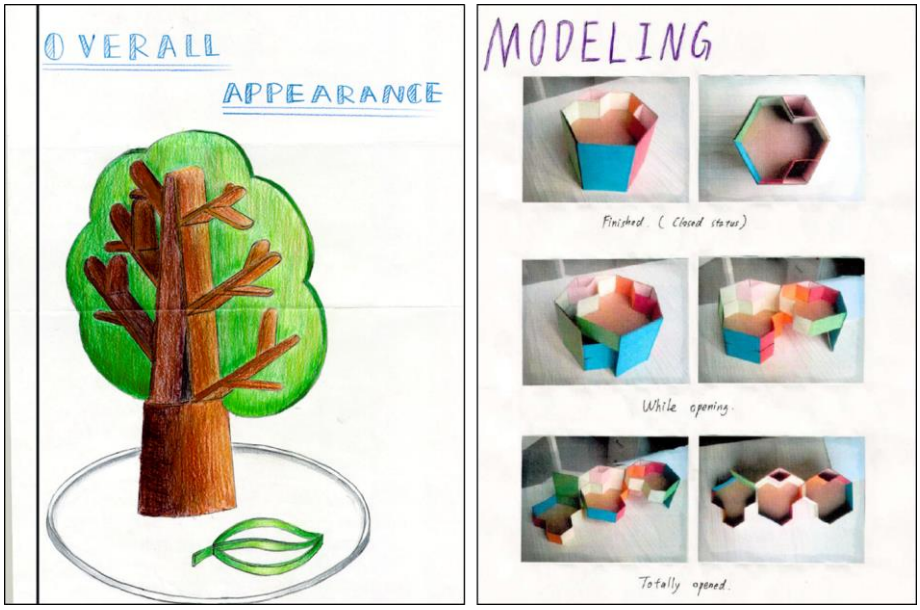


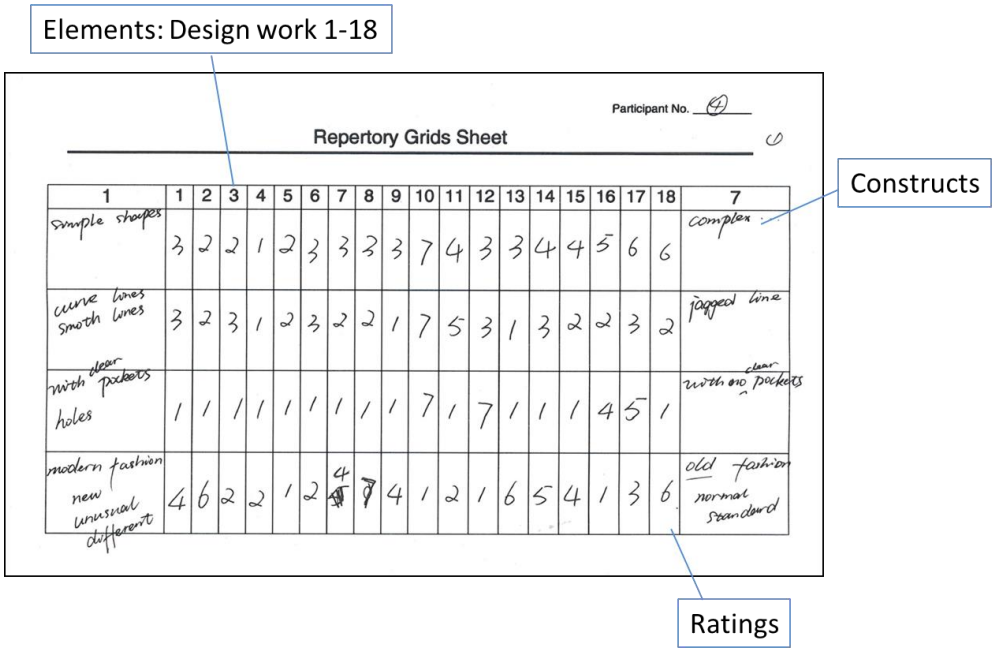
Figure 4.2 Examples of Chinese students' designs

A total of 30 participants were recruited to this study, comprised of two equal groups: UK & Chinese. Professional background was also taken as a variable of influencing the design evaluation. The participants consisted of two subgroups: the general public and qualified designers. The composition of the participants of each group was as follows: ten members of the general public (five male and five

female, with ages ranging from 21 to 71 years. The mean age for the UK male group was 35.0, and female 42.6, and the Chinese male group was 32.4, and female 37.4) and five qualified designers (with a degree in any design discipline), with three of the UK designer and two of the Chinese designers being female.

The study was designed based on the relevant ethical principles and has been reviewed according to the ethical review processes in place at the University of Nottingham, Faculty of Engineering, and also the Ningbo campus. The relevant participant information sheets and consent forms can be found in Appendix 4A.

There are three main components in a full repertory grid technique. The first is 'Constructs', which are the basic units of participants' descriptions and interpretations. According to Kelly's original theory, people tend to construct their own interpretation of the world by using polar definitions; generating these constructs is one of the vital themes in a repertory grid technique. 'Elements' is another key component, which are the samples chosen to represent the area where interpretation is to be investigated (Fransella 1977). The third component is 'Ratings', which refers to how the participants interpret each element on each construct. Applied to this study, the elements are the 18 designs, which were used to present the UK and Chinese designs. The constructs are the pairs of descriptions elicited from each participant, which represent their understanding of the designs; the ratings stand for their evaluation of each design according to the constructs they developed themselves. Figure 3 shows these three basic components in a repertory grid sheet.



1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	7
simple shapes	3	2	2	1	2	3	3	3	3	7	4	3	3	4	4	5	6	6	complex
curve lines smoth lines	3	2	3	1	2	3	2	2	1	7	5	3	1	3	2	2	3	2	jagged line
with clear pockets holes	1	1	1	1	1	1	1	1	1	7	1	7	1	1	1	4	5	1	with no clear pockets
modern fashion new unusual different	4	6	2	2	1	2	4	7	4	1	2	1	6	5	4	1	3	6	old fashion normal standard

Figure 4.3 An example of a repertory grids sheet used in this study

4.4 Procedure

Although theoretically there are no limitations to the number of elements (in this study the designs) in a repertory grids interview, a large number of elements would make it time-consuming and frustrating for the interviewee. Therefore this study restricted the number to 18, to ensure enough variety of the samples and to make the interviews efficient and productive. Ideally, 816 possible combinations of 3 designs from a set of 18 (i.e. C (18, 3) = 816) would be used as a full comparison for all these designs, however this was impractical. In this study, using Excel, a random arrangement form determined the groups (Table 4.1). In this form there were 21 sets of 18 numbers (1 to 18) arranged randomly, each containing 6 combinations of 3 designs and in each combination there was at least one element from the UK designs and one from the Chinese designs. This form was used to ensure that during each interview every design would be considered by the interviewee at least once.

The participants were asked to choose a set of the combinations randomly from the table at the beginning of the interviews. For every combination of three designs, participants were asked “which two of these designs are alike in some way, and different from the third?” They were encouraged to supply at least one

similarity/difference for each combination and laddering down (by asking the question 'how, what way?') and up (by asking 'why' to find out the meaning of the construct for the participant) procedures were applied each construct to obtain a clear answer and a deeper understanding of their interpretation (Jankowicz 2003). Then participants were asked to rate the designs on each of the elicited descriptions using a seven-point scale. Take an example shown in Figure 4.3 to illustrate the procedure, one construct was "modern fashion" vs. "old fashion". The participant indicated that for "modern fashion" it referred to the attributes such as "new, unusual, different" and for "old fashion" it meant "normal, standard" (laddering down). Then a rating was given to each of the eighteen designs using a scale in which "1" was the "modern fashion" end and "7" was the "old fashion" end. The same procedure continued until no new descriptions occurred for two consecutive triads. At this point, participants were asked to rate all the designs on aspects of aesthetics, creativity and usability (if the constructs elicited from them did not include these aspects) using the same rating scale, as these aspects are commonly used when evaluating designs (Dorst & Cross 2001; Nikander et al. 2014). To ascertain if any new thoughts were inspired by these questions, the participants were then asked if any additional construct came to mind. They were then given an overall evaluation construct which assessed the extent to which they judged the designs as either "bad design" or "good design".

The interviews with the Chinese participants were conducted in Chinese and the results were translated into English by the researcher. Not including the overall evaluating constructs, a total of 298 constructs were obtained, numbering 159 from the UK group and 139 from the Chinese group. This was deemed to be suitable numbers for the comparison between the UK and Chinese groups.

Table 4.1 Random arrangement form of 18 designs

4	5	14
1	8	13
6	3	17
16	18	9
11	10	7
15	12	2

2	3	16
1	6	17
4	7	18
11	14	9
12	10	8
13	15	5

7	5	17
6	4	11
1	8	14
15	16	9
10	12	3
13	18	2

4	8	13
2	3	18
7	9	11
15	16	1
14	10	5
17	12	6

4	1	10
6	9	17
5	8	12
11	14	3
18	16	7
13	15	2

6	2	12
3	9	18
4	5	11
13	14	7
16	15	1
17	10	8

1	9	12
8	6	10
4	7	11
14	17	2
16	18	3
15	13	5

3	9	12
7	4	17
2	1	11
18	10	8
16	13	5
15	14	6

8	6	11
2	5	18
1	7	14
16	12	9
13	15	4
17	10	3

2	3	15
5	4	12
9	8	13
17	14	7
11	16	1
10	18	6

8	1	10
4	9	11
5	2	17
13	16	7
18	14	3
12	15	6

1	5	17
9	8	12
6	7	14
15	16	3
18	13	2
11	10	4

2	3	15
6	1	16
7	8	11
18	14	5
17	13	9
10	12	4

5	8	17
2	3	18
6	7	13
10	11	1
15	16	9
14	12	4

5	3	11
1	4	10
7	2	15
13	16	8
18	14	6
17	12	9

8	5	11
3	6	16
2	1	10
12	13	9
14	17	4
18	15	7

7	1	10
4	6	17
5	9	11
15	16	2
18	13	3
14	12	8

7	4	18
1	9	12
5	2	16
17	11	3
13	14	8
10	15	6

4	9	17
6	3	13
7	1	10
15	12	2
14	16	8
18	11	5

5	4	11
9	8	15
1	3	12
18	14	2
17	13	7
10	16	6

9	3	16
5	4	14
1	6	11
13	10	8
17	15	7
18	12	2

4.5 Analysis and results

The analyses were to address the two dimensions of the research aim: 1) to identify **the differences in the evaluation of design outcomes** between the two groups of general users; 2) to reveal **the differences in the design outcomes** from the perspective of the different groups of student designers.

4.5.1 Differences in the evaluation of design outcomes

4.5.1.1 Do any differences exist?

Content analysis was first conducted on the 298 personal constructs from the two cultural groups. Content analysis in repertory grid technique is a way in which the constructs of all the interviewees are brought together and classified based on their meanings (Jankowics, 2005). A classification following the core-categorisation procedure introduced by Jankowicz (2005) was applied to the categorisation, which is indicated as follows:

> Each description (construct) being categorised is compared with the others, and then:
>
> 1. If a description is in some way similar to the first description, the two are placed together under a single category created for them at that moment. For example, in this study, the first description shown in the repertory grid sheets is the construct of 'simple, one piece' vs. 'complex' which is describing the structure of the designs, then if the next is also describing the structure such as 'customisable, changeable' vs. 'rigid, inflexible, not customisable', these two descriptions will be placed together at the moment under a category named 'form/structure'.
> 2. If a description is different to the first description, they are put into separate categories. Taking the same example mentioned above, if the next description is of the aesthetics aspect of the designs such as 'pleasing to the eye' vs. 'not pleasing to the eye', then they will be put into two different categories of 'form/structure' and 'aesthetics' respectively.
> 3. The remaining items are compared with each of the categories and allocated to the appropriate one if an appropriate category already exists.
> 4. A new category is created if required; when a new category is created, the possibility that existing categories need to be redefined (combined or broken up, with their items reallocated accordingly) is considered and effected as necessary.
> 5. This process continues until all the items have been classified.
> 6. All unclassifiable items are placed in a single category labelled 'miscellaneous'.
> 7. No more than 5% of the total are categorised as 'miscellaneous'.

The core-categorisation was conducted by the researcher independently. As it was to some extent a subjective procedure, mainly based on the researcher's

personal judgement, a reliability check collaborator was introduced. The procedure was developed on the procedure of reliability check also from Jankowicz (2005), which is shown as follow:

1. The collaborator identifies the categories. (The same procedure as above)
2. Tabulate the result
3. Identify the categories both the researcher and the collaborator agree on, and those they disagree on.

a. Establish a reliability table (show Table 4.2)

b. Jot down the definitions of the two category sets; discuss the categories, and agree on which ones mean the same.

c. Rearrange the rows and columns of the reliability table.

d. Record the joint allocation of constructs. Working from the two separate content-analysis tables, record the position of each of the constructs into the reliability table.

e. Measure the extent of the agreement between the researcher and the collaborator.

The overall measure of agreement is as follows:

- The number of constructs which lie along the diagonal
  In all the categories the researcher and the collaborator were both in agreement
- As a percentage of all of the constructs in the whole table

f. Negotiate over the meaning of the categories.

g. Finalise a revised category system with acceptable high reliability.

Repeat the whole analysis again, using these new categories.

h. Report the final reliability figure.

Firstly, the collaborator followed the first two steps and the results were compared with the one from the researcher. However, it turned out that although the basic understanding of the constructs was similar, there were quite large differences in the labels of categories that were used. Therefore, instead of following Jankowicz's procedure strictly, the first two steps were changed. A discussion was conducted at the beginning of the procedure and a list of categories were developed based on this discussion, which was also changed gradually in the following repeat round of step 1 and step 2 until total agreement was reached. Then step 3 was conducted to the new results that were redone by

researcher and collaborator according to the agreed categories. After 3 rounds of reliability check, a final reliability figure of 90.3% was achieved (Detailed categories can be found in Appendix 4B).

Table 4.2 Reliability table

Collaborator		1	2	3	4	5	6	7	8	9	10	11	12
Interviewer		form / structure	aesthetics	ergonomics	design style	creativity	design concept	functionality	commercial aspect	manufacture	user-centred	technology	miscellaneous
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													

To explore the original information from all participants, the supplied constructs were taken out of the categorization and the results are presented in Table 4.3. A total of nine categories were identified from all the constructs. The category of **aesthetics** covered those that commented directly on the overall aesthetic features or detailed features, such as colour. The category of **form/structure** could also be placed under the label of aesthetics, as they are related to appearance features. However as there were quite a large number of constructs relating to this category, it was classified independently. **Functionality** refers mainly to the quality or number of functions, although some may also refer to a specific function shown in the design. The category of **usability** refers to aspects such as convenience, ease of use, practicality of use and usefulness. The category of **creativity** is related to novelty of functionality, design ideas, or appearance. There was a fair proportion of constructs which were **judgements based on the design process**, such as style of sketching and the quality of drawing. These constructs were divided into three sub-categories: **design process**, **drawing/presentation** and **design style**.

Table 4.3 Categorization of Constructs (not including applied constructs)

Category		Definition	Sum	UK-GP	UK-QD	CN-GP	CN-QD
Aesthetics (AES)		Words/phrases related aesthetic features such as the appearance, colour, etc.	17	6	2	5	4
Form/structure (F/S)		Words/phrases about the features in the overall or detailed form/structure	75	29	7	23	16
Functionality (FUN)		Words/phrases related to the functionality of the design	20	9	3	6	2
Usability (USA)		Words/phrases related to convenience, usefulness and practicality of the design	32	10	5	14	3
Creativity (CRE)		Words/phrases about the creativity in form/functionality/design ideas, etc.	7	3	1	3	0
Manufacture (MAN)		Words/phrases about the features shown in the manufacturing process	5	1	3	1	0
Judgement based on the design process (JBDP)	Design process (DP)	Words/phrases about the design process showing in the sketches	11	3	5	3	0
	Drawing/presentation (D/P)	Words/phrases about the way the designer presents the design	14	1	5	1	7
	Design style (DS)	Words/phrases about the overall style shown in the design	28	10	7	7	4
Commercial aspect (CA)		Words/phrases about the business features shown in the design	5	2	1	2	0
Miscellaneous (MIS)		Constructs that cannot be categorised to any of the others	3	1	0	1	1
Totals			217	75	39	66	37

Note. GP = general public, QD = qualified designer, UK /CN = UK /China

Table 4.4 Relative percentage of categorization of constructs (not including applied constructs)

Category		UK-GP	UK-QD	CN-GP	CN-QD
Aesthetics (AES)		8	5	8	11
Form/structure (F/S)		39	18	35	43
Functionality (FUN)		12	8	9	5
Usability (USA)		13	13	21	8
Creativity (CRE)		4	3	5	0
Manufacture (MAN)		1	8	2	0
Judgement based on the design process (JBDP)	Design process (DP)	4	13	5	0
	Drawing/presentation (D/P)	1	13	2	19
	Design style (DS)	13	18	11	11
Commercial aspect (CA)		3	3	3	0

Miscellaneous (MIS)	1	0	2	3
Totals	100	100	100	100

Note. GP = general public, QD = qualified designer, UK /CN = UK /China

Table 4.4 shows the relative percentages (i.e. the number of constructs of each aspect / the total number of constructs of each group) of each group. Notable differences were found between the two groups of designers. In the aspects of **Aesthetics** and **Form/Structure**, Chinese designers tended to pay more attention compared to their UK counterparts, with a total percentage of 54 (11+ 43) compared to 23 (5 + 18) respectively. On the other hand, the UK designers paid more attention to the aspects of **Functionality**, **Usability** and **Creativity** (with the percentages of 8, 13 and 3 respectively). They also valued aspects of **Manufacture** and **Design process** (8, 13), which were aspects for which the Chinese designers seemed to have no interest (0, 0).

However, for the groups consisting of members of the general public, a high degree of similarity was found in the percentages shown in Table 4.4. Except for a small difference shown for the aspect of **Usability**, in which the Chinese group tended to show more attention than their counterpart, the numbers for all other categories were very close between the two groups. To investigate whether there was a difference, a chi-square test was conducted to explore the independence of the categorical variables. The aim of this test was to demonstrate if there was a relationship between the UK and Chinese general public groups in their categorising performance. The variables here are the Cultural background vs. Categorising performance. The null hypothesis is that the cultural background and the categorising performance are independent. According to the test, X^2_{obs} = 2.84. X^2_{crit} (df =10; $p < 0.05$) = 3.94 > X^2_{obs}, therefore fail to reject the null hypothesis, which means that there is no relationship between cultural background and categorising preference for the general public groups.

So far, it appears to be correct to conclude that from the performance of categorising the constructs, no significant differences could be found between the general public groups. The core-categorisation conducted above revealed, to some extent, the different meanings expressed by all four participant groups.

However, in line with Jankowicz's (2005), the results were achieved at the cost of not using the ratings of the elements, which are vital resources produced in the original repertory grid technique. Thus, to make full use of the data from all participants, the content analysis method from Honey (1979) was also applied to the data (Jankowicz, 2005). Honey's content analysis interprets each participant's constructs through the ratings and content. It is a practical tool when investigating the relationship between all other constructs elicited from any individual participant and their overall interpretation about the specific topic. One of the key components in Honey's content analysis is the overall interpretation, which in this study is the overall evaluation of the excellence of the designs. It was elicited with the question: "As a general feeling: how would you rate each of them on a scale that goes from 'good design'=1, to 'bad design'=7?" This method calculates the differences between the ratings of each construct and the overall constructs, then converts the differences into percentage similarity scores to ensure comparability with other grids (1).

$$100 - \frac{SD}{(LR-1)\times E} \times 200 \quad (1)$$

Based on the similarity scores, each individual's constructs were grouped into highest (H), intermediate (I) and lowest (L) third. The "H" constructs are the ones that are close to the overall "good design vs. bad design" constructs. The relative percentages of the number of "H" constructs are shown in Table 4.5.

Differences are obvious for the two groups of general public in the relative percentage of the number of "H" constructs. For example, in regard to the aspects of **Aesthetics** and **Form/Structure**, although the added percentage of these two aspects from these two groups were close (with UK 36 vs. CN 32), the UK general public tended to pay less attention to Aesthetics (17 vs. 29) whilst giving more attention to **Form/structure** (19 vs. 3). There is also a significant difference in the aspect of **functionality**, in which the UK group developed only 3 per cent of their overall constructs whilst the Chinese group had 13 per cent. To compare it to the results of core-categorisation, a chi-square test was conducted and an $X^2_{obs} = 27.54$ was obtained; X^2_{crit} (df = 7; $p < 0.05$) = 2.17, which was much

smaller than X^2_{obs}, therefore the null hypothesis was rejected, and this confirms that there were significant differences between the two groups in the number of "H" constructs.

Based on the analyses above, the conclusions drawn are that: 1) Both the UK and Chinese general public groups tended to use a similar range of criteria for evaluating designs; however, they also gave different degrees of importance to these criteria when it came to the overall evaluation of the designs; 2) There were significant differences in evaluating designs between the UK and Chinese designers.

Table 4.5 Relative percentage of the number of "H" constructs

Category		UK-GP No. of H (relative percentage %)	UK-QD No. of H (relative percentage %)	CN-GP No. of H (relative percentage %)	CN-QD No. of H (relative percentage %)
Aesthetics (AES)		17	24	29	31
Form/structure (F/S)		19	6	3	25
Functionality (FUN)		3	0	13	0
Usability (USA)		31	18	35	13
Creativity (CRE)		14	18	13	6
Manufacture (MAN)		3	6	0	0
Judgement based on the design process (JBDP)	Design process (DP)	6	6	3	0
	Drawing/presentation (D/P)	0	6	0	19
	Design style (DS)	8	18	3	6
Commercial aspect (CA)		0	0	0	0
Miscellaneous (MIS)		0	0	0	0
Totals		100	100	100	100

4.5.1.2 What is (are) the difference(s)?

Table 3 shows that all four groups of participants relied heavily on the appearance of the design when making their evaluation; as the categories of **Aesthetics** and **Form/structure** took a large proportion of the total number of "H" constructs. Apart from the Chinese general public group, the percentages of **Aesthetics** + **Form/structure** were the highest amongst all the categories.

The Chinese general public group attached slightly more significance to the **Usability** category than the **Aesthetics** + **Form/structure** categories, which indicates that they took the utility and the appearance as the two most important criteria in judging the designs. The third and fourth ranking categories were **Functionality** and **Creativity**. The UK general public group also placed equal importance on the utility and appearance categories as their two most important criteria. However, compared to the Chinese group, which paid more attention to the overall aesthetic features (i.e., high aesthetically-pleasing vs. low aesthetically-pleasing, good-looking vs. not good looking), the UK group tended to focus more on the form/structure features (i.e., straight lines vs. curved lines, simple structure vs. complex structure). **Creativity** is important for both general public groups, and they rated this as the third most important criteria. The Chinese general public group was the only group to rate the features of f**unctionality** (i.e., single functionality vs. multiple functionality; simple functionality vs. systemic functionalities) as equally important as **Creativity**.

The designer groups tended to place less significance on **Usability** and **Functionality**. They focused more on aspects based on the design process, among which the UK designers focused more on the overall **Design style** (i.e. artificial vs. natural, complex solution--simple solution) while the Chinese designers thought highly of the quality of **Drawing/presentation** (i.e. weak in sketching skills --proficient sketching skills, weak three-dimensional effect--strong three-dimensional effect). The Chinese designers placed more emphasis on **Aesthetics** and **Form/structure**; while the UK designers valued **Creativity**. The top three aspects from each group are listed in Table 4.6.

Table 4.6 Summary of the top 3 categories of each group

	No.1	No.2	No.3
UK-GP	Aesthetics + Form/structure	Usability	Creativity
UK-QD	Aesthetics + Form/structure	Usability / Creativity / Design style	
CN-GP	Usability	Aesthetics + Form/structure	Functionality / Creativity
CN-QD	Aesthetics + Form/structure	Drawing / presentation	Usability

4.5.2 Differences in the design outcomes

This section presents the test of the differences in the two groups of designs from the perspective of the different groups of participants, which means to explore the relationships among all the elements in the repertory grids. Structure analysis in repertory grids is mainly concerned with the relationships between and within the elements and the constructs (Jankowicz, 2005) which were not revealed by Honey's content analysis. To investigate the differences from the perspectives of both the cultural and professional background, the 30 grids were again divided into four groups, namely: the UK general public, the Chinese general public, the UK designers and the Chinese designers.

4.5.2.1 Do any differences exist?

Cluster analysis was first introduced to the analysis of repertory grid data by Shaw (1980). By arranging the most similar ratings to lie side by side, each of the constructs and elements were reordered. That is, each construct given by each participant was tabulated (a section of this table is visible in Figure 4.4). The row order was arranged such that the most similar ratings were next to one another, as evidenced by the clusters of high ratings towards the bottom corners of the table in Figure 4.4. The dendrograms of the constructs and elements are presented respectively on the right and bottom of the Cluster analysis graph, and shown together with a similarity scale. Usually, in a cluster analysis graph of individual grids, the dendrograms of the element show how the participant categorise all the elements. The dendrograms of constructs show how every construct is correlated with each other. The analyses are based on these two dendrograms and reveal how this participant categorised these elements based on his/her own way of interpreting the specific theme.

Cluster analysis was applied to each of the four groups and differences were found in the dendrogram of the element of each analysis graph (Appendix 4C-4F). Take the UK general public group for example (Figure 4.4), where there are three distinct clusters in the dendrograms: Cluster 1 contains designs 1, 2, 3, 4, 5; Cluster 2 contains designs 13, 14, 18 and Clusters 3 contains designs 12, 15, 16.

The shape of these clusters demonstrates that for the ten UK participants, according to some certain attribute, the UK designs (design 1 to 9) and the Chinese designs (design 10 to 18) tended to fall into distinct groups. Similar situations exist in the elements dendrogram parts of each of the four groups.

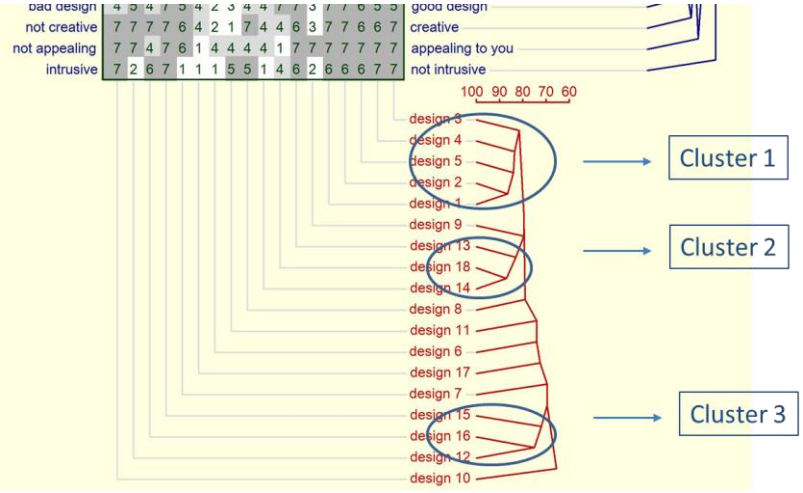


Figure 4.4 Cluster analysis graph of the UK general public group (dendrogram of element part)[2].

This result was also validated by the Principle Component Analysis (PCA), which is another commonly used tool in repertory grid analysis (Appendix 4G-4J). As Jolliffe (2002) asserted, the core idea of the PCA is to reduce the dimensionality of a data set that consists of a large number of interrelated variables while keeping as much existing variation as possible in the data set. In a PCA graph (see Figure 4.5), the horizontal and vertical axes represent two of the most significant variabilities that exist in the ratings of the constructs. The other lines lying across the four quadrants represent the constructs, with the two sides representing the two anchors of each construct. The angle between any two construct lines represents the correlation between the descriptions: i.e. the smaller the angle, the more similar the ratings. The angle between a construct line and the component line also represents their correlation in the same way. The dots on the graph indicate the elements, namely the designs. Their positions on the graph demonstrate their correlation with the component lines, the constructs line and also to each other. (Jankowicz, 2005) In general, the PCA is used to

[2] Design 1-9 are UK designs and design 10-18 are Chinese designs, similarly hereinafter

analyse a single grid. If it were used to interpret a sophisticated construct system, the two components shown on a two-dimensional map would be illustrating less than the total picture (Slater 1976; Easterby-Smith 1981). In this study, the data of each group comprised 5 or 10 participants' grids (either designers or general public), which made the construct system more complex and therefore, the two components here only represent a relatively small percentage of the total picture (the lowest is from the Chinese general public group, with 23.3% of the first component and 19.4% of the second component, giving a total of 42.7%). Although the percentage taken by the two components is relevantly low, the coincidences shown in each group were still surprising findings given the vague essence of culture. Take the UK general public group for example, the positions of the elements in Graph 6 show clearly that – the UK designs tend to gather in an area close to each other, as do the Chinese designs. Similar situations exist in the PCA graphs of the other three groups.

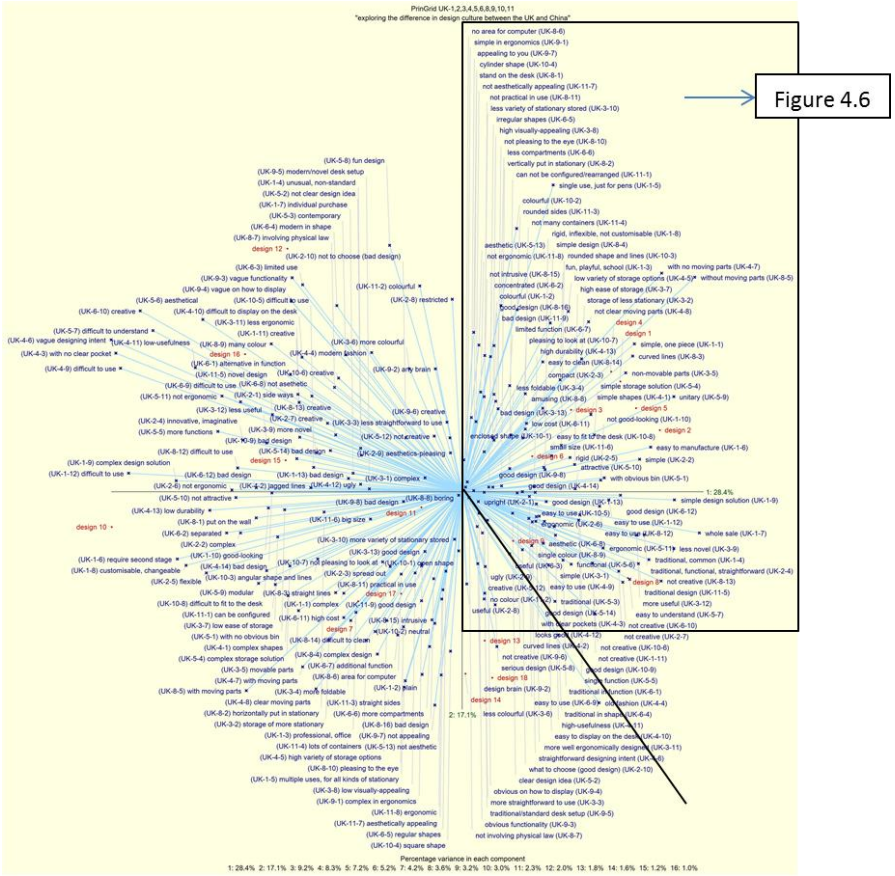


Figure 4.5 PCA graph of the UK general public group

4.5.2.2 What is the difference(s)?

The similarities in the grouping of elements in the two analysis methods above make it reasonable to assert that there were some characteristics in the UK and Chinese designs that differentiated them from each other. The following analysis was to determine the precise nature of these characteristics. According to the basic theory of PCA, a close position on the graph confirms a high correlation between the constructs and the elements. By checking the positions of the lines (constructs) and the dots (designs), it is possible to identify the designs that are most similar to each other, and also the constructs that are closely related to the designs. For example, in Figure 4.6, Design 1 and Design 4 were close to each other, which means that the two designs were highly similar according to the UK general public group. In the close area of the two designs, there were constructs lines such as “simple, one piece”, “curved lines”, “non-movable” which means that the two designs shared these characteristics. Due to the large number of constructs, it is neither straightforward nor realistic to distinguish all the characteristics in this way. To solve this problem, a special method was applied to conduct the analyses - each graph was divided into the “Chinese design area” and “UK design area” (which means the specific area in the graph primarily occupied by Chinese or UK designs respectively). Take the PCA graph from the UK general public group for example, most of the UK designs were located in the area that was shown in Figure 4.6 except for Design 7, therefore this area was defined as the “UK design area”. The constructs that appear in this area were analysed to capture the main characteristics in the UK designs. To make the outcome clearer, only the “H” constructs (identified by Honey’s content analysis) were taken for analysis. The “H” constructs that appear in the UK / Chinese design area from each group are categorised and listed in Tables 4.6 -9.

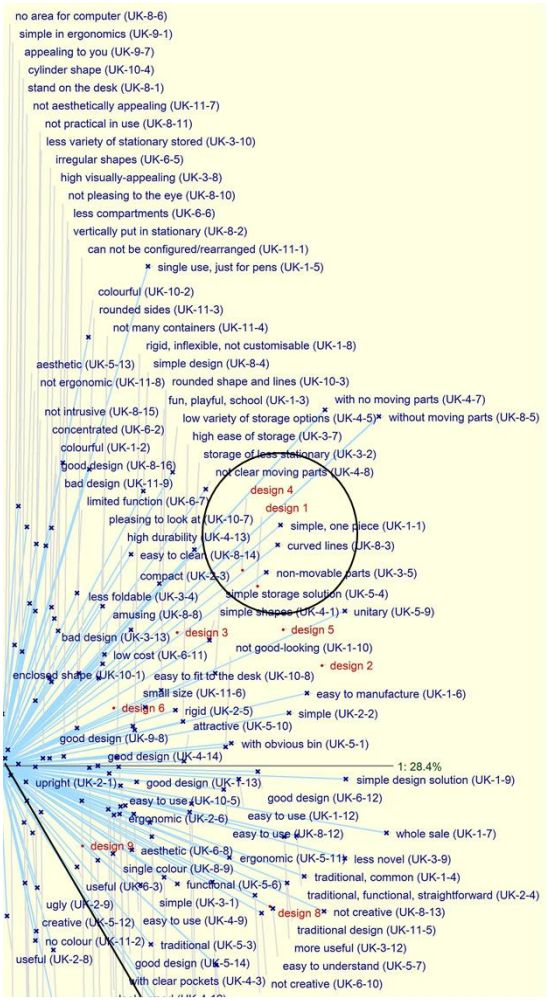


Figure 4.6 "Chinese design area" of PCA graph of the UK general public group

The results shown in Tables 4.7 and 4.8 indicate the common aspects and differences between the evaluation of the general public groups of the designs. The UK group (Table 4.7) tended to think that the UK designs were more aesthetically pleasing than the Chinese designs. To them, UK designs tended to have these characteristics: round shape, fixed structure, with pocket form design, with less functions, less creative but easier and practical in using/displaying/cleaning. The Chinese designs tended to have a square shape, changeable structure, with no clear pocket design but with more functions, much more creative, but also not so easy or practical in using/displaying/cleaning. Because the Chinese designs tended to have changeable structures which were also more complex, they would also be more difficult to manufacture. They also thought that UK designers had much clearer design ideas shown in the design process and tended to produce simpler solutions to meet the design

requirements. Overall, they thought that UK designs were much better than Chinese designs. On the other hand, the Chinese general public group (Table 4.8) tended to think that the Chinese designs were much more aesthetically pleasing. They had a similar judgement in terms of the Chinese designs tending to have complex structures and more functions and greater creativity than the UK designs. However, they judged the Chinese designs to be easier/more practical with regards to using/displaying/cleaning the products, which is in contrast to the judgements of the UK general public. They concluded that the Chinese designs were much better than the UK designs.

Table 4.7 Number of "H" constructs in the UK / Chinese design area from the UK - GP group

	Category		Two anchors of the constructs	UK designs	CN designs
UK-GP	**Aesthetics**		Aesthetically pleasing	3	3
			Not aesthetically pleasing	2	4
	Form / structure		Rounded shape	3	0
			Square shape	0	3
			Fixed structure	3	0
			Changeable structure	0	3
			With clear pocket	1	0
			No clear pocket	0	1
	Functionality		More functions	0	1
			Less functions	1	0
	Usability		Easy / practical to use / display / clean	9	2
			Not easy / practical to use / display / clean	2	9
	Creativity		Creative (modern)	0	4
			Not creative (traditional)	5	1
	Manufacture		Easy to manufacture	1	0
			Difficult to manufacture	0	1
	Judgement based on the design process	Design process	Clear design idea	1	0
			Vague design idea	0	1
		Design style	Simple design solution	3	0
			Complex design solution	0	3
	Overall judgement		Good design	7	2
			Bad design	2	7

Compared to the sharp contrast shown in the results from the general public groups, the results from the designers groups tended to be more moderate

(Table 4.9 – 4.10). Although the UK designers (Table 4.9) thought that the UK designs were much more aesthetically pleasing than the Chinese designs, they did not simply group them into simple or complex structures. In the usability aspect, they also thought that the two groups of designs were equal in terms of ease/practicality and using/displaying/cleaning. The Chinese designs were still seen as more creative, while they were not thought to be so suitable for manufacture when compared to the UK designs. For the judgements based on the design process, they thought that the UK designs indicated solutions compared to the complex solutions from the Chinese students, but they were judged to demonstrate equal levels of expertise. Based on all the judgements, they assessed the UK designs as slightly better than the Chinese designs.

Table 4.8 Number of "H" constructs in the UK / Chinese design area from the CN-GP group

	Category		Two anchors of the constructs	UK designs	CN designs
CN-GP	**Aesthetics**		Colourful	0	1
			Neutral	0	1
			Aesthetically pleasing	1	7
			Not aesthetically pleasing	6	2
	Form / structure		Rounded shape	0	1
			Square shape	0	1
			Simple structure	1	0
			Complex structure	0	1
	Functionality		More functions	0	4
			Less functions	3	1
	Usability		Easy / practical to use / display / clean	2	8
			Not easy / practical to use / display / clean	4	6
			Small space occupation	1	0
			Large space occupation	0	1
	Creativity		Creative (modern)	0	4
			Not creative (traditional)	4	0
	Judgement based on the design process	Design process	Design idea from abstract shape	1	0
			Design idea from existing image	0	1
		Design style	Normative, traditional, formal	1	0
			Cartoon style, vivid image	0	1
	Overall judgement		Good design	2	8
			Bad design	6	4

Table 4.9 Number of "H" constructs in the UK / Chinese design area from the UK - QD group

	Category		Two anchors of the constructs	UK designs	CN designs
UK-QD	**Aesthetics**		Aesthetically pleasing	4	0
			Not aesthetically pleasing	0	4
	Form / structure		Simple structure	0	0
			Complex structure	1	1
	Usability		Easy / practical to use / display / clean	2	1
			Not easy / practical to use / display / clean	2	1
	Creativity		Creative (modern)	0	3
			Not creative (traditional)	1	2
	Manufacture		Suitable for manufacture	1	0
			Not suitable for manufacture	0	1
	Judgement based on the design process	Design process	Clear design idea	1	0
			Vague design idea	1	0
		Design style	Simple design solution	2	0
			Complex design solution	1	1
		Drawing / Presentation	High level of expertise	1	0
			Low level of expertise	1	0
	Overall judgement		Good design	4	1
			Bad design	3	2

Meanwhile, the Chinese designers (Table 4.9) did not address any vital differences in the overall aesthetics aspects as they found the levels varied within the designs. However they did actually distinguish some differences, namely that the Chinese designs tended to have rounded shapes, complex structures which would make them difficult to manufacture, and also that they were more creative. They thought that UK designs tended to have square shapes, simple structures and therefore more easy to manufacture, but also did not show much creativity. They did not find any notable differences between the two groups of designers' expertise. They judged it varied within each group rather than between the groups. However, when it came to their overall judgements, they thought that the Chinese designs were much better.

Table 4.10 Number of "H" constructs in the UK / Chinese design area from the CN-QD group

	Category		Two anchors of the constructs	UK designs	CN designs
CN-QD	**Aesthetics**		Colourful	0	1
			Neutral	0	1
			Aesthetically pleasing	0	4
			Not aesthetically pleasing	0	4
	Form / structure		Rounded shape	2	0
			Square shape	0	2
			Simple structure	2	0
			Complex structure	0	2
	Usability		Easy / practical to use / display / clean	0	2
			Not easy / practical to use / display / clean	2	0
	Creativity		Creative (modern)	0	1
			Not creative (traditional)	1	0
	Manufacture		Easy to manufacture	1	0
			Difficult to manufacture	0	1
	Judgement based on the design process	Design style	Interesting	0	1
			Boring	0	1
		Drawing / presentation	High level of expertise	0	2
			Low level of expertise	0	2
	Overall judgement		Good design	0	5
			Bad design	3	2

4.5.3 Overview of the results

The analyses above take into consideration the content of the constructs and also the relationship between and among the constructs and elements to reveal the differences in the evaluating criteria from both the UK and Chinese participants, and the differences shown in the UK and Chinese designs from their perspectives. It shows that for the judging criteria, there were common aspects and also differences between the UK and Chinese participants. When using these criteria to judge the 18 designs, obvious differences were found. These differences can be found in the aspects of overall aesthetics evaluation, detailed form/structure, usability, functionality, creativity, etc. General images of the UK and Chinese designs could be summarised as follows: the UK designs tended to have rounded shapes, simple structures, fewer functions and less creativity, whereas the

Chinese designs tended to have squarer shapes, complex structures, more added functions (e.g. can store more different types of stationery) and also showed greater creativity. Such findings were confirmed by all four groups of participants.

Due to their professional background, designers tended to judge the designs from different perspectives than the general public groups. In this study, it is evident that they paid more attention to the design process, design style and also the quality of drawing/presentation. They also judged creativity from different aspects, which led to their judgement on creativity being slightly less extreme between the UK and Chinese designs. From their results, there is evidence of differences between the UK and Chinese groups, but also differences within each group. However, despite all the differences in the judging criteria, the significant result is that for both the general public groups and the designer groups, the designs from the designers from their own culture were thought to be better than those from the other culture.

4.6 Discussion

4.6.1 The use of Repertory Grids and its analysis in this study

The repertory grid technique is an appropriate but under-utilized tool in the culture measurement literature. In this study, by applying the repertory grid technique to the comparison of 18 designs from both UK and Chinese design students, the interpretation of four groups of participants was mapped from several different aspects. The ratings from the repertory grids process quantified the participants' thoughts into measurable and comparable results. This solved one problem of using interviews as a method of measuring culture, which usually leads to difficulties in quantifying the results. In the opening stage of this study, one hypothesis was that there would be no differences between the UK and Chinese groups, because of the increasing globalisation and homogeneity of all aspects of people's daily lives, or if there was a difference it would not be significant enough to be measurable. Even during the interview process, the differences were not obvious, as all the participants tended to select similar descriptive parameters and gave similar ratings to each of the 18 designs. After

each interview, the researcher asked the participants if they could distinguish the designs by the designers' nationality, and most of them failed. However, from the results of the repertory grids above, it is evident that they were able to reflect the differences between the UK and Chinese participants in a distinct way; which makes the comparison of the role of culture in product design between the UK and China more practical.

In the analysis of repertory grids results, a method of content analysis was proposed which combines both core-categorisation and Honey's content analysis. It allowed an in-depth exploration of the cross-cultural differences between UK and Chinese people's criteria for evaluating designs. A method of combining Honey's content analysis with the Principle Components Analysis was also proposed to reveal the differences that exist in the design work from an individual's idiosyncratic view. The introduction of Honey's content analysis also solved the limitations proposed by Hassenzahl and Wessler (2000) regarding application of repertory grid technique. By comparing the differences among the overall rating and all other ratings, it identified the good or bad attributes of the designs from the participants' point of view and helped to determine relationships between constructs. Because the aim of this study was to investigate the cultural differences, the "useless" descriptive constructs that Hassenzahl and Wessler suggested (compared to evaluative constructs) actually offered a large amount of information in revealing the attributes that exist in the designs.

Due to the large amount of data, the differences found were to some extent related more closely to the categories that were generated by the content analysis, rather than directly exploring the information elicited from each individual. The perceptions of the designs from each of the two cultures were refined from the overall performance of each group, and not ascribed to any individual participants. Also, restricted by time of each interview, this study did not address the aspects arising from the result (i.e., aesthetics, creativity, usability, etc.) to a deeper and more detailed level. For example, it was not clear what kind of criteria were used by each participant when they were judging

creativity and what were the differences among the groups in the criteria. Although in the laddering down and up process more detailed information captured, they were not explored very deeply. A further study has been conducted to explore how UK and Chinese people maybe differentiated from each other in each evaluation aspect.

4.6.2 The role of culture

The results reveals significant differences among the UK and Chinese design outcomes as well as the differences in judging designs design outcomes between the UK and Chinese people, which leads to the exploring of the ultimate question of this research -- what is the role of culture behind these differences?

Before moving on to the final question, it is reasonable to discuss beforehand the relevancy of the data that have been collected and its representativeness of being a sample for cross-cultural comparison. As Hosftede et al. (2010) indicated in their book, although various paper-and-pencil questionnaire studies have been conducted to investigate people's preference among alternatives, the answers elicited from them should not be taken too literally, because it could be that the way people act in reality does not represent the answer they provided in the questionnaire. In a similar way, the results from the repertory grids interviews do not necessarily represent the actual situation when UK and Chinese people were facing real design products. However, Hofstede et al. (2010) also pointed out that this kind of situation and this type of study still delivers useful information "because they show differences in answers between groups or categories of respondents" (P28). The exact descriptions from UK and Chinese participants may not be representative when they are applied to individual UK or Chinese people; however the differences shown in the conclusion between these two groups of participants to a certain extent reveal the cultural difference between these two countries' people when they are judging design outcomes.

4.6.2.1 Curved lines vs. Angled lines

One of the conclusions from the repertory grid can be easily related to the **Indulgence indices** of UK and China, which are the obvious differences captured

by both UK and Chinese participants—the UK designs tend to have rounded shapes; whilst the Chinese designs tend to have square shapes. Relative descriptions related to this feature also include 'curved lines', 'rounded lines', etc., vs. 'jagged lines', 'angled lines', etc. Just as Lundholm (1921) indicated in the paper The Affective Tone of Lines, "Slow and weak movement is suggested by lines with long and low waves, rapid and intense movement by lines with small waves and acute angles". The differences shown in the forms of designs illustrate a "slow and weak movement" style in UK designs and a "rapid and intense" style in Chinese designs. In Hofstede et al.'s (2010) cultural dimension, he defined Indulgence as "a tendency to allow relatively free gratification of basic and natural human desires related to enjoying life and having fun" and its opposite anchor, restraint, "a conviction that such gratification needs to be curbed and regulated by strict social norms". He also listed the key differences between indulgent and restrained societies such as, for the former one, "loose society", "higher importance of leisure", "less moral discipline", etc., versus "tight society", "lower importance of leisure", "moral discipline", etc. According to a report Four Psychological Changes among Chinese People in the Past 20 years (Xia 2014) from Southern Weekly (China), cynicism is in a booming way in current China society because of the negative psychological status that are common among the people. This kind of situation manifests itself as an impotent feeling of in charging of things, distrust, unsafety and uncertainty about the future, etc., which makes China society goes further in the way of Restraint. On the other hand, the UK has a much higher Indulgence index than China. These types of differences in the cultural background may lead to the "slow and weak movement" and the "rapid and intense" style shown in the designs respectively.

4.6.2.2 Simplicity + less functions vs. Complexity + more functions

From another point of view, the relatively restrained life style of the Chinese, to some extent, maybe also attributed to the feature that Chinese designs tend to have more functions than its UK counterparts, which is also related to the Simplicity (with clear pockets design) versus Complexity features (with no clear pocket design). More UK designed stationery racks are only simple "pots" as a

pen holder, while Chinese designs tend to have different components for different types of stationery. In the key differences between Indulgence and Restrained societies, Hofstede et al. (2010) mentioned the attribute of “thrift is not very important” Vs. “thrift is important”. By reflecting this difference in design, the UK designers tended to design a stationery rack as simple desk tidy; while Chinese designers tended to design more functionality so as to make full use of it and prevent any possible waste. On the other hand, the difference between these two countries in the **Time orientation dimension** may also suggest some of the deeper reasons for this kind of phenomenon. According to Hofstede, China is a typical nation with long-term orientation as a consequence of the long history of the teachings from Confucius. The long-term society tend to be “thrift, being sparing with resources”, rather than “social pressure toward spending”; pursue long-term profit rather than focus on short-term interests. Therefore in terms of design, the designers tend to think rather more than just focus on the essential functions of the product.

Hall’s (1989) **dimension of high and low-context**, to some extent, also suggests some explanation to the simplicity shown in the UK designs and complexity in the Chinese designs. According to Hall, in the high-context cultures, the outside environment is found to be much more important than the inside settings. High-context communication has been identified as being indirect, ambiguous, maintaining of harmony, reserved, and understated (Gudykunst et al. 1996). The Chinese tend to communicate in a high-context way, which relies highly on the information that is maintained in the environment. Therefore, the designs, which are a significant part of the daily environment, tend to be complex so as to deliver more information than they orally expressed. On the contrary, UK people are in a low-context system, in which low levels of programmed information are used to provide context. The interpersonal communications are largely dependent on the information to be direct/explicit, precise, dramatic, open, and are based on feelings or true intentions (Gudykunst et al. 1996). Correspondingly, their physical environment tends to be simple and carrying less information.

4.6.2.3 Uncreative vs. creative

Nevertheless, there are also features shown in the conclusion of repertory grid that appear to contradict Hofstede et al.'s (2010) theory. According to both UK and Chinese participants, the Chinese designs are much more creative than the UK designs. While refering to the **Individualism Index**, UK people tend to be more individualistic and Chinese people tend to be more collectivistic. Hofstede described collectivism as "use of the word 'I' is avoided", "conceive of him- or herself as part of 'we'", which can be hardly related with words such as 'creative' and 'innovative' that mean to be different from the majority. There are, in fact, several empirical studies that have contradicted the cultural value conclusions on individualism vs. collectivism. Schwartz (1994) and Triandis et al. (1990) found that Chinese valued creativity more highly than did Americans (typical individualist society). Also, in their study of preferences in friendships, Goodwin and Tang (1991) found that the Chinese emphasis on creativity as a preferred characteristic much more than their UK counterparts.

4.6.2.4 Self-appreciation

Another feature in the conclusion that contradicts the cultural theory is the self-appreciation that was apparent in the Chinese participants. In the aspects of aesthetics, usability, creativity and the overall good and bad design judgement, Chinese participants all tended to think designs from Chinese designers are better than UK ones. This contradicts the self-serving biases vs. self-effacing biases theory from the conclusions of some previous studies. Like Bond asserted (1991) in his book of Beyond the Chinese face: Insights from psychology stated that the Chinese tended to show a lower level of self-serving biases but a higher level of self-effacing biases than Westerners; which means that Chinese are more likely to think others to be better than themselves, while westerners tended to think the opposite. This theory also agrees with Hofstede's **Time orientation**, in which he described "Short-term orientation societies" as "proud of my country" and "monumentalist" but "Long-term orientation societies" as "learn from other countries" and "flexhumble". However, according to the results of repertory grid analysis, Chinese participants show a high appreciation of the designs that are

from Chinese designers but limited interest in the designs from the UK, which has obviously contradicted these cultural hypotheses. One possible explanation for this phenomenon is that all the designs were anonymised to the participants when they did all their judgements. A conclusion can be drawn from this kind of phenomenon that although between UK and Chinese people there are different cultures in self-appreciation patterns, when facing daily design products, they are more likely to be attracted to the designs from their own culture.

4.6.3 The influence of professional background

The participants' professional background was also used as one of the variables in this study. The results showed that there were differences between the general public and qualified designers in their criteria for judging designs, but they were not as significant when compared to the cultural differences. This result suggested that even for qualified designers, cultural influence is still tremendously important and it echoes with Tomico et al. (2009) who stated that designers' cultural backgrounds affect design preferences. Future work is needed to explore the cultural difference in products from the perspective of designers.

4.7 Conclusion

This study set out to explore the cultural differences in the features of design outcomes in the UK and Chinese designs and in the evaluation of design outcomes in the UK and Chinese people. It suggested the use of repertory grid technique in detecting cultural differences and its detailed application. The results confirmed that the differences exist in both of the two dimensions. Firstly, it reveals vital differences in the UK and Chinese designs in the aspects of complexity, the features of lines, shapes and structure, the numbers of functions and the creativity. It also indicates the differences in the evaluation of design outcomes in the aspects of aesthetics, usability, creativity. Further studies are needed to investigate the differences in the evaluation of design outcome in further detail.

5 AN ONLINE SURVEY TO VALIDATE AND EXPLORE DIFFERENCES IN DESIGN EVALUATION

5.1 Chapter overview

This chapter presents the study of an online questionnaire that was conducted using a random sample of the UK and Chinese general public, which aimed to validate and further explore the results from Study 1 in the dimension of the differences in the evaluation of design outcome. It reports the detailed design of the study, which was carried out in the form of online questionnaire and investigated the evaluation on the aspects of aesthetics, ergonomics in utility and creativity from UK and Chinese participants.

5.2 Introduction

Study 1 identified differences between UK and Chinese people in their preferences in designs. The differences mainly existed in the aspects of aesthetics, perceived ergonomics (usability, functionality) and creativity. However, due to the limited time of each interview using the repertory grids, it was not revealed how these groups of people can be differentiated in these three aspects. For example, it was still not clear how these three aspects were weighted in the evaluation of designs, and how the details from each aspect influenced the evaluation. Therefore, an online questionnaire survey was conducted to validate the differences found in Study 1 and also to explore the identified differences in greater depth. The validity used in this study was concurrent validity which is a form of criterion validity according to Wilson and Sharples (2015, Chap. 1). It was to validate whether the performance in the evaluation criteria between the larger sample of UK and Chinese general public compared well to differences found in Study 1 elicited from a small sample size. The method of online questionnaire was applied to ensure the quantity of responses necessary to achieve statistical significance.

A large proportion of research that investigates the differences in design evaluation among different cultures are from the perspective of country of origin,

i.e. the information pertaining in a product to where it is made (Chattalas et al. 2008; Hsieh & Pan 1995; Byoungho et al. 2010; Zhang 1996). Among research, Chinese culture is always a popular target due to the tremendous growth potential of Chinese market. However, the studies focused more on the culture images from the point of view of marketing, rather on the design attributes themselves. For example, the study from Byoungho et al. (2010) found that the Chinese consumers valued price as the most important attribute, followed by fitting, brand country of origin, quality and design, compared to their Indian counterparts. The study from Zhang (1996) investigated Chinese consumers' product evaluations, attitudes and product choices from the perspective of perception of country of origin images. There was also research that explored the cultural differences in design attributes in web site design (Cyr et al. 2005; Cyr et al. 2010; Marcus & Gould 2000) and interface design (Downey et al. 2005; Evers & Day 1997), but web site design is very different from product design. Given all that, there is still a gap for research that address culture differences in evaluation of product design attributes.

This study investigated the differences in design evaluation from the perspective of visual appearances. As Bloch (1995) claimed, "a good design attracts consumers to a product, communicates to them, and adds value to the product by increasing the quality of the usage experiences associated with it". The exterior form is the most fundamental characteristic of a product and it could be more important than its tangible properties according to specific motivations and context (Crilly et al., 2004). Norman (2004) also claims that aesthetical attributes could have more influence on user preferences than traditional operational usability. The halo effect has offered a good explanation to the importance of visual experience, which applied to the design domain could be interpreted as the aesthetics can also influence judgements on other aspects such as its usability and the overall user satisfaction etc. (De Angeli et al. 2006). This study examines aspects of aesthetics, ergonomics and creativity from the perspective of visual appearances.

5.2.1 Aim and objectives

This study used the method of online questionnaire to ask people to rate products according to different parameters that were developed in the aspects of aesthetics, ergonomics (perceived) in utility and creativity. The overall aim of this study is to validate and also further explore the differences in the evaluation of design outcomes between the UK and Chinese general public. The specific objectives are:

- To validate the identified differences in the perception of design between UK and Chinese people with a larger sample, in the aspects of aesthetics, perceived ergonomics and creativity, and in overall judgement;
- To explore the differences in more detail with structured questions – what are the detailed differences that exist in each aspect, and how the differences influence the overall judgement on design outcome.

5.2.2 Hypotheses of study

Based on the results of Study 1 in the dimension of the evaluation of design outcomes, two hypotheses were drawn in this study:

1. There are differences in the judgement of the given products: UK people were expected to place aesthetics as the most important evaluation criterion, whereas Chinese people were expected to value more of the ergonomics in utility aspect.
2. Differences are expected to be found in the specific aspects of aesthetics, ergonomics in utility and creativity, and also in the overall judgement.

5.2.3 Research model

Section 2.2.6 describes the detailed aspects of the evaluation of aesthetics, ergonomics and creativity in the design area. In this research, due to the limitation of the format of an online survey, the three aspects were mainly measured at a ‘perceive’ level, namely judging based on appearance of products.

Due to the nature of design activities, **aesthetics** is one of the most important features of a design. It is in the aesthetic experience of a product that all the senses are gratified (Desmet & Hekkert 2007). In the evaluation of aesthetics, colour, shape, texture, materials, style etc. are the common physical properties that were perceived, which together generate certain appearance attributes associated with the overall design experience (Blijlevens et al. 2009). The evaluation of aesthetics in this study was also mainly based on these physical properties.

The development history of **ergonomics** shows an extension from objective performance related to functional, performance-related issues such as safety, usability, ease of use and effectiveness to subjective aspects that were closely related to product image, impression, lifestyle-fit etc. (Han et al. 2000; Fulton Suri & Marsh 2000). Because of the limitation of online survey, the ergonomics aspects that were evaluated in this study were more about perceived ergonomics in utility from the pictures of product that were shown in the questionnaire: i.e.it deals with more on the subjective aspects rather than objective aspects as it was more related to the ergonomics that were perceived from the images.

It is never an easy job to evaluate the **creativity** of products (i.e. design outcomes). Researchers normally define and evaluate it in several dimensions using an assessing model, such as the four-dimensional of relevance & effectiveness, novelty, elegance and generalizability from Cropley and Cropley (2005) and the six-dimensional model that consists of Novelty, Resolution, Emotion, Centrality, Importance, and Desire proposed by Horn & Salvendy (2009). The evaluation of creativity in this study was primarily creativity in visual perception; therefore the dimensions were limited to certain extent. It detected the creativity from the two basic perspectives of appearance and usage.

Based on the literature, a research model (Figure 5.1) of online design outcome evaluation was developed in this study. The model is constructed of the design evaluation based on the aspects of aesthetics, ergonomics (perceived) in utility and creativity but also decomposed each aspect into further details. It was also a

compromise solution considering the feasibility of online research and all the evaluations were based on the physical properties that could be perceived from pictures of products. The aspect of aesthetics referred to the attributes in colour, shape, styling & decoration and material. The aspect of ergonomics mainly explored the attributes in size & weight, safety of use, and eases & comfort of use. The aspect of creativity was mainly evaluated from the appearance and usage. There were hierarchical structure between the detailed attributes and each aspect and also the overall design evaluation in this model. It was designed to explore the weight of each attribute in its respective aspect and also in the overall evaluation.

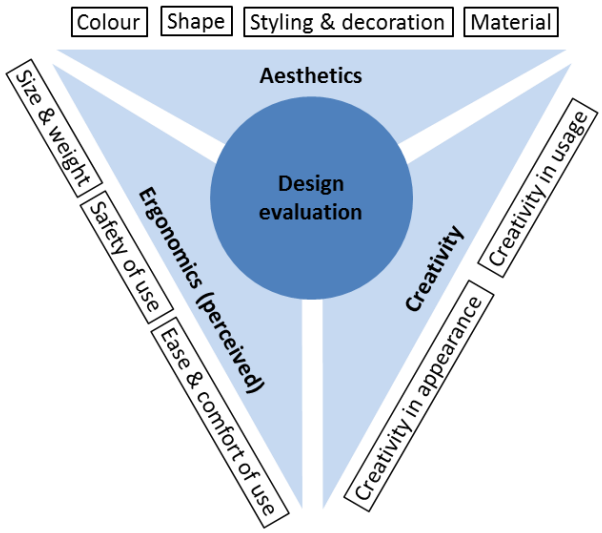


Figure 5.1 Research model of online design evaluation

5.3 Method

5.3.1 Design of the questionnaire

5.3.1.1 Samples of products

In order to validate the results from Study 1 outside an academic environment, the sample of designs in this study were existing products available in the market place instead of design concepts in the previous study. After repeated sifting, criteria for the designs were established. The products needed to: 1. have neither a too complicated nor a too simple manufacturing process; 2. be in current daily

use by both UK and Chinese people; 3. be relevant to both male and female users.

Due to the cultural differences, identifying products that were common for both nationalities was challenging. Some products, for example, toasters, and coffee machines in the UK or rice cookers in China, are far more familiar to one side of the target population. In the first stage, the products considered were bathroom scales, kettles, computer mice, desk lamps and hair dryers, which seemed to be equally accepted by both populations. However, with the development of the questionnaire, the detailed questions made it quite time-consuming to complete. The types of product were therefore cut to only three types. These were the **bathroom scales**, **kettles** and **computer mice**. They are daily use products that are equally familiar to both the UK and Chinese people but at the same time different from each other and have features that are representative for quite a large scale of daily use products. For example, bathroom scales normally use batteries, kettles are electrical and computer mice are relatively high-technology. Two examples of each type of product were selected from the most popular ones on the Internet-based retailer Amazon (from amazon.co.uk and amazon.cn respectively). Amazon is popular in both the UK and China and the popularity rankings in the website make the comparison between the products feasible and convenient. Figure 5.2 shows the selected products. Each product was also presented in different views, to give the participants a comprehensive perception, in the questionnaire. The online questionnaire was designed based on the relevant ethical principles and has been reviewed according to the ethical review processes in place at the University of Nottingham, Faculty of Engineering. The participant information sheet and consent form were presented in the first page of the online questionnaire to the potential participants (Appendix 5A).

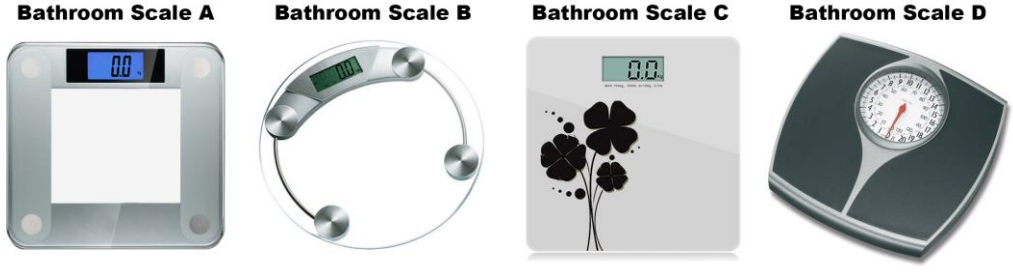




Figure 5.2 three types of products used in the online questionnaire

5.3.1.2 Pilots studies

Based on the principle of making it easy and not too time-consuming so as to collect data from as many participants as possible, the questionnaire used multiple-choice as the main question format. In order to exhaust the possible choices of each aspect for each product, pilot studies were conducted to explore the design of the questionnaire.

In the first two rounds of pilots, all the questions were asked in the form of short questions. For example, the question “what are the main considerations when you assess the aesthetics?” was used to elicit the main concerns about judging aesthetics of a specific product. The pictures of the products were shown along with the questions. Four people were interviewed in these two pilot rounds. Three of them were Research Fellows from the Human Factors Research Group of The University of Nottingham, of whom one has a design background. The other one was a member of the general public with no academic or design background. After the first two rounds of pilots, the possible considerations that related to the three main aspects of the products (i.e. aesthetics, utility and creativity) were basically exhausted. A questionnaire of multiple choice questions was developed based on all the collected pilot answers. The following two rounds of pilots were to test the questionnaires duration and any problems that might emerge when

answering the questions. The five participants for these pilots were from the general public and the pilots were run online. Resulting from the feedback from these pilots, the number of questions was cut down to make it quicker and easier to complete. The arrangement of questions and the format of the whole questionnaire were also adjusted to make it more user-friendly.

After four rounds of pilots, questions for each aspect were mainly confirmed. For the aesthetics aspect, the questions were mainly focused on the colour, shape, styling, decoration and material. For the creativity aspect, it was mainly about creativity in appearance and creativity in usage. For the aspect of utility, different types of questions emerged during the pilots such as judgements on safety, comfort, ease of use; evaluation of the design of some key parts; judgements on the shape, size of specific parts/ the overall design and the evaluation of the functionality. However, due to the limitation of online research, not all of them were suitable for this questionnaire. After some discussions with the supervisors, the perceived size and weight, the perceived safety of use and the perceived ease and comfort of use were selected as the three main aspects to include in the test. Although an online questionnaire is not the perfect test method to test the aspect of utility and the depth of investigation is limited, if considering the online shopping behaviour in real life, the judgement of perceived utility is a vital part during the real decision making process. The listed questions have their practical meaning and were maintained as part of the questionnaire. Detailed questions for each group of products can be found in Table 5.1 below.

One of the main aims of the questionnaire was to find how participants related judgement on all the provided aspects of the designs to their overall evaluation. Therefore there was an overall evaluation of all the designs before each specific question. The final three groups of products, namely four bathroom scales, four kettles and four computer mouse, were labelled as Product 1A, 1B, 1C, 1D; 2A, 2B, 2C, 2D and 3A, 3B, 3C, 3D (shown in Figure 5.1). For each group of products, there was a first question to rank 4 products from 1 to 4 (where 1 is the most preferred and 4 is the least preferred). Then each product was evaluated by

questions from the aspects of aesthetics, perceived ergonomics in utility and creativity, with a rating scale from 1 to 7 (1-very poor, 7-very good).

Table 5.1 Questions on each aspect of the products in the questionnaire

Product 1: Bathroom scales	
Aesthetics	Colour Shape Styling and decoration Materials used? (e.g. texture, strength)
Ergonomics in Utility	Perceived size and weight? (e.g. mass, dimensions, lightness) Perceived safety of use? (e.g. surface, overall shape) Perceived ease & comfort of use?
Creativity	Creativity in appearance Creativity in usage
Product 2: Kettles	
Aesthetics	Colour Shape Styling and decoration Materials used? (e.g. texture, strength, surface)
Ergonomics in Utility	Perceived size and weight? (e.g. mass, dimensions, lightness) Perceived safety of use? (e.g. the design of the spout, opening & handle, material used) Perceived ease & comfort of use?
Creativity	Creativity in appearance Creativity in usage
Product 3: Computer mouse	
Aesthetics	Colour Shape Styling and decoration Materials used? (e.g. texture, strength, surface)
Ergonomics in Utility	Perceived size and weight? (e.g. mass, dimensions, lightness) Perceived ease & comfort of use? (e.g. size, shape, number and positions of buttons, the way each button operates)
Creativity	Creativity in appearance Creativity in usage

5.3.1.3 Problems in conducting the questionnaire

The English questionnaire was launched in the Bristol Online Surveys system (www.onlinesurveys.ac.uk/) and the Chinese questionnaire was launched in the website of www.sojump.com, a professional Chinese online questionnaire website. Although they were in different languages, both these two questionnaire were designed in a uniform format so as to keep the user experience as uniform as possible.

At the opening stage of this study, when the questionnaire was first put online, one problem arose from the replies that had been reviewed. As the questions under each product were listed on the same page of the online questionnaire, some participants tended to give the same or very similar ratings to the questions under each product. To prevent this kind of bias, the questionnaire was redesigned by splitting the questions under each aspect into separate pages.

5.3.2 Recruitment and sampling

Based on the aim of validating the results of Study 1 with a larger sample from UK and Chinese populations, a random sampling method was used in this study. The participants were targeted at the general public from both cultures. The recruitment information was promoted via social networking applications such as Facebook and WeChat through the researcher's account, and also via email list of the research group and relevant acquaintance. The recruitment lasted for about 3 months and in total there were 128 questionnaires collected from the Chinese general public and 65 from the UK. The demographic information of the participants from these two countries can be found in the Table 5.2 and Figure 5.3-5.6 below.

The number of Chinese participants was about twice of the UK ones; if the population of each country is taken into consideration (UK 95 million, China 10,403 million, 2015), these numbers are reasonably comparable. The demographic information, such as gender, age, marital status and annual income were also collected in the questionnaire. The annual income was set as an optional question due to ethical considerations. In the area of cross-cultural study, the importance of using matched samples is always stressed. Unequal samples will lead to the difficulty of determining whether any attitudinal or behavioural differences were due to cultural differences or other demographic factors (Hofstede et al. 2010; Reid 2011). Table 5.2 shows the two samples had quite matched data on all the demographic characteristics that were collected, which also means the effect of differences in demographic factors has been reduced to a very low level.

Table 5.2 Demographic information of participants of the questionnaires

	CN	UK
Gender		
Male	53	21
Female	75	44
Age		
under 20	30	7
20-29	75	23
30-39	22	15
40-49	0	13
50-59	0	5
above 60	1	2
Marital status		
Married	40	17
Single	83	40
Other	5	8
Income (per year)[3]		
Under £16000	80	35
£16000-22999	24	14
£23000-31999	10	10
£32000-39999	8	6
Above £40000	6	0

Figure 5.3 shows the gender information from each of the participant groups. Both groups had more female than male participants. For the UK group, there was approximately twice the number of female to male participants. Generally speaking, the demographics were quite close between these two groups when considering the nature of random sampling.

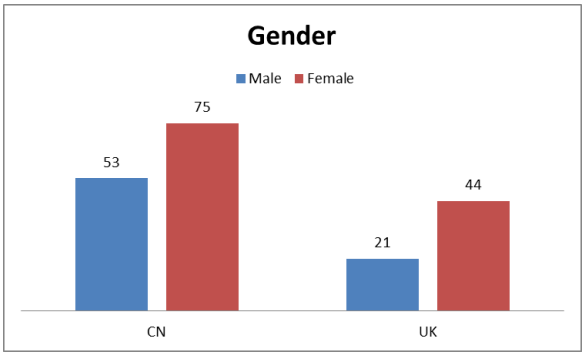


Figure 5.3 Gender information of the participants of the two questionnaires

[3] For the Chinese participants, the income categories were: under ¥50000, ¥50000-¥71999, ¥72000-¥99999, ¥100000-¥124999 and above ¥125000, which were equivalent to the UK income categories from http://www.workpermit.com/uk/hsmp_countrylist.htm.

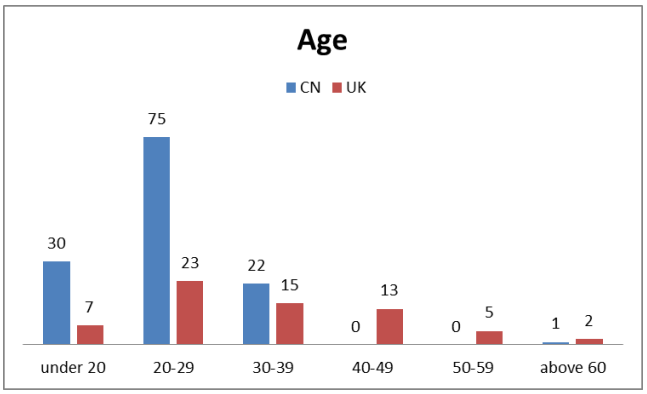


Figure 5.4 Age information of the participants of the two questionnaires

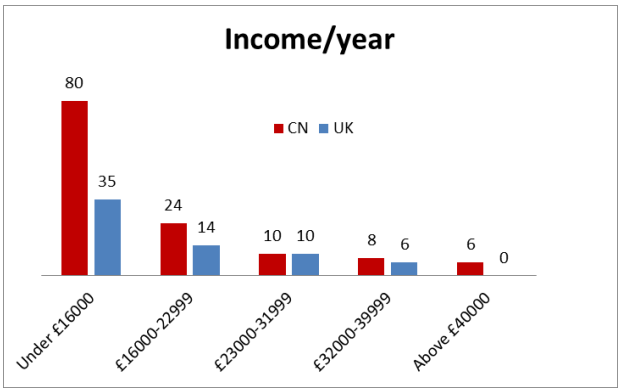


Figure 5.5 Annual income information of the participants of two questionnaires

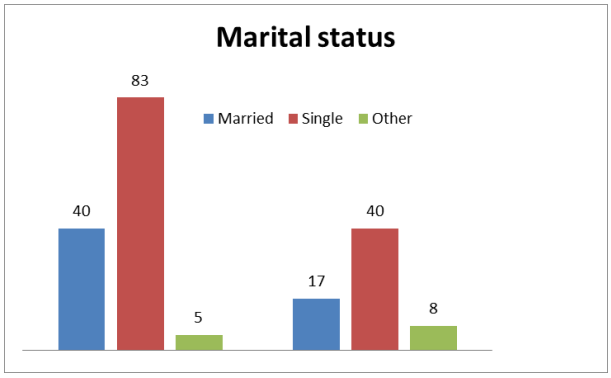


Figure 5.6 Marital status information of the participants of the two questionnaires

From Figure 5.4, the two groups of participants varied considerably in age. The Chinese group had more young respondents, among whom 105 were under the age of 29. Whilst for the UK group, participants were relatively equally located in each age range, with slightly more people from the age of 20 - 29. Corresponding to the younger age, Chinese groups also had a lower annual income compared to their UK counterparts, with about two thirds of them located in the lowest income level, namely under ¥50000 (Figure 5.5).

Marital status has been proven to have significant influence on individuals' consumer behaviour (Laroche et al. 2001) and therefore was also measured in the questionnaire. The result shown in Figure 5.6 indicates that the two groups of participants had a quite close marital status profile. Both groups had more single samples than married ones; the former was about twice the number of the latter.

5.3.3 Data transformation – converting rank values to an interval scale

As Dowling and Midgley (1991) stated, it is always easier for people to rank items than to make decisions about the intervals between them. In this study, also by considering the possibility of overlapping the ratings on the overall judgement, a ranking system from 1 to 4 (where 1 is most preferred and 4 is least preferred) was applied to the overall judgement on all the products. On the other hand, due to the ordinal nature of rank values, which only indicate the order but says nothing about the differences between values, there are also limits on the range of 'valid' statistical analysis that can be conducted. Therefore for the judgement of all the specific aspects, a rating scale from 1 to 7 (1-very poor, 7-very good) was used to obtain interval data. When it came to the analysis part, to interpret the correlation between the overall judgements and all the other judgements on the specific aspects, it was necessary to convert the rank values into an interval scale. A complex transformation of the rank values was conducted following the method introduced by Bock and Jones (1968 chap. 8).

5.3.3.1 Procedure

Table 5.3 presents the actual data of rank values that were assigned to each product by the 65 UK participants. In total there were four categories of ranking, namely 1, 2, 3 and 4. There were 12 items, namely the three groups of four different products. Firstly, the frequency of rankings was transformed into cumulative proportions of ranking. As suggested by Dowling & Midgley (1991), one adjustment was applied to the original route proposed by Bock and Jones (1968 chap. 8). The midpoint of the proportion of each category, rather than a whole proportion, was transformed here (Table 5.4). Because the midpoint of each category, which had the equidistance from the upper bound of the last

category and from the lower bound of the next category, stands for the middle value of the proportion. Therefore it could be taken as an equivalent value of each category. For instance, the midpoint of Category 3 (the column of the rank value of 3), which was equidistant to the upper bound of Category 2 and the lower bound of Category 4, was taken as an equivalent value for Category 3. Take the data of Category 3 of the Product 1A as an example: there were 17 of rank '3' and in total there were 65 rank values For Product 1A. The midpoint of the proportion of rank 3 would be (2'2+2'3+17/2)/65, which equates for 0.823 (the 22 and 23 in the equation is the number of rank value '1' and '2' for Product 1A).

The midpoints of cumulative proportions of each category (P values) were then transformed into interval Z scores (Table 5.5). To make the converted rank values comparable to the rating scores of all the following questions, the smallest Z score was set at 1.000 and the highest 7.000, the Z scores were transformed into rescaled equivalents as shown in Table 5.6. This technique was developed from the one used by Sharples and Cobb (2015) when conducting ranking calculations. Another thing to consider here was that, as the proportion of data was transformed by using the Category 1 (the column of the rank value of 1) as the first proportions, which meant the accumulation was started from the highest rank value to the lowest ones. Whilst for the rating value, 1 stands for the "very poor" end and 7 stands for the "very good" end. To make the converted values as uniform as the rating scales, the converted Z score was reversed using the equation: reversed value = 8 – Z score in Table 5.7. The rank values from the Chinese groups were also transformed using the same procedure and the final converted data is shown in Table 5.8. These values, named as Rescaled Rank Values (RRV), were used to replace each of the rank values from the participants for each product.

Table 5.3 Numbers of each rank value of each product from the UK participants[4]

	Rank value				
Product 1	1	2	3	4	N
1A	22	23	17	3	65
1B	21	23	14	7	65
1C	12	12	23	18	65
1D	10	7	11	37	65
Total	65	65	65	65	
Product 2	1	2	3	4	N
2A	10	25	21	9	65
2B	36	15	7	7	65
2C	3	8	20	34	65
2D	16	15	18	16	65
Total	65	63	66	66	
Product 3	1	2	3	4	N
3A	28	22	10	5	65
3B	21	18	11	15	65
3C	9	18	32	6	65
3D	7	7	12	39	65
Total	65	65	65	65	

Table 5.4 Midpoint of Cumulative Proportions of rank value numbers of each product from the UK participants

	Midpoint of Cumulative Proportions, P, of Ranking Value			
Product 1	1	2	3	4
1A	0.169	0.515	0.823	0.977
1B	0.162	0.500	0.785	0.946
1C	0.092	0.277	0.546	0.862
1D	0.077	0.208	0.346	0.715
Product 2	1	2	3	4
2A	0.077	0.346	0.700	0.931
2B	0.277	0.669	0.838	0.946
2C	0.023	0.108	0.323	0.738
2D	0.123	0.362	0.615	0.877
Product 3	1	2	3	4
3A	0.215	0.600	0.846	0.962
3B	0.162	0.462	0.685	0.885
3C	0.069	0.277	0.662	0.954
3D	0.054	0.162	0.308	0.700

[4] For Product 2 group, the total numbers of each rank value were not uniform due to some participant assigning the same rank value to some products. It could have been this participant's real intention or it could also have been only a mistake. The data was kept as it was.

Table 5.5 Z scores, associated with P values from the UK participants

	Z scores, associated with P			
Product 1	1	2	3	4
1A	-0.958	0.038	0.927	1.995
1B	-0.986	0.000	0.789	1.607
1C	-1.329	-0.592	0.116	1.089
1D	-1.426	-0.813	-0.396	0.568
Product 2	1	2	3	4
2A	-1.426	-0.396	0.524	1.483
2B	-0.592	0.437	0.986	1.607
2C	-1.995	-1.238	-0.459	0.637
2D	-1.160	-0.353	0.292	1.160
	1	2	3	4
3A	-0.789	0.253	1.019	1.774
3B	-0.986	-0.095	0.482	1.200
3C	-1.483	-0.592	0.418	1.685
3D	-1.607	-0.986	-0.502	0.524

Table 5.6 Rescaled equivalents of Z scores from the UK participants

	Rescaled equivalents, Make Highest Z score = 7, lowest = 1			
Product 1	1	2	3	4
1A	1.000	3.024	4.830	7.000
1B	1.000	3.282	5.107	7.000
1C	1.000	2.829	4.586	7.000
1D	1.000	2.845	4.099	7.000
Product 2	1	2	3	4
2A	1.000	3.124	5.022	7.000
2B	1.000	3.808	5.306	7.000
2C	1.000	2.726	4.502	7.000
2D	1.000	3.087	4.755	7.000
Product 3	1	2	3	4
3A	1.000	3.439	5.233	7.000
3B	1.000	3.446	5.029	7.000
3C	1.000	2.688	4.600	7.000
3D	1.000	2.748	4.111	7.000

Table 5.7 Reversed converted values from the UK participants

	Reversed converted values			
Product 1	1	2	3	4
1A	7.000	4.976	3.170	1.000
1B	7.000	4.718	2.893	1.000
1C	7.000	5.171	3.414	1.000
1D	7.000	5.155	3.901	1.000
Product 2	1	2	3	4
2A	7.000	4.876	2.978	1.000
2B	7.000	4.192	2.694	1.000
2C	7.000	5.274	3.498	1.000
2D	7.000	4.913	3.245	1.000
Product 3	1	2	3	4
3A	7.000	4.561	2.767	1.000
3B	7.000	4.554	2.971	1.000
3C	7.000	5.313	3.400	1.000
3D	7.000	5.252	3.889	1.000

Table 5.8 Reversed converted values from the Chinese participants

	Reversed converted values			
Product 1	1	2	3	4
1A	7.000	5.013	3.129	1.000
1B	7.000	4.882	2.999	1.000
1C	7.000	4.725	3.201	1.000
1D	7.000	5.376	4.142	1.000
Product 2	1	2	3	4
2A	7.000	4.885	3.061	1.000
2B	7.000	4.267	2.953	1.000
2C	7.000	4.859	3.016	1.000
2D	7.000	5.772	4.612	1.000
Product 3	1	2	3	4
3A	7.000	4.667	2.914	1.000
3B	7.000	4.444	2.658	1.000
3C	7.000	5.530	3.605	1.000
3D	7.000	5.221	4.075	1.000

5.4 Results

The study was designed to address the two main aims, namely to validate the differences that were identified by Study 1 with a larger sample and to explore

the differences in further details. Due to the nature of the cultural comparison of this study, a between-subjects design was used.

To explore whether the differences from Study 1 also existed in these two larger samples, three-way mixed design analysis of variance (ANOVA) were conducted to the RRV and ratings on each aspect of each of the products. The dependent variable was the RRV and all the ratings. The independent variables were **cultural background**, namely Chinese participants vs. UK participants and **product type** (i.e. the four different types of each product), namely the four different products of each product group, and also the **different aspects** of criteria for judging designs on which the questions were asked, namely the overall rank values, the colour, the shape, etc. Among all the independent variables, the product type and different aspects were the within-subjects variables, and the cultural background was the between-subjects variable. The analysis of the ANOVA would be mainly focused on the three-way interactions (i.e. three-way interaction between products*aspects and cultural backgrounds), which stand for the differences show on the rating between the two different cultural groups.

Furthermore, hierarchical regression analyses were applied to predict the RRV (dependent variable) on the products based on all the three aspects (independent variables), namely the aspects of aesthetics, ergonomics in utility and creativity. The model and the relative contribution of each of the predictors (i.e. the independent variables) would be compared to investigate the differences between UK and Chinese participants in their evaluation of specific products from the detailed aspects.

5.4.1 A comparison of UK and Chinese participants

A Three-way mixed ANOVA was performed to investigate whether differences exist in the effects of product type (products), different aspects (aspects) and cultural backgrounds (culture) on ratings from the participants on three products, namely the bathroom scales, kettles and computer mouse. Before running of the ANOVA, the assumptions were checked to confirm if the data met the test assumptions. According to the normality test of the data, the Shapiro-Wilk index

showed that the data were not normally distributed. However, due the due to the relatively large number of samples (UK 65, CN 128) and also considering the robustness of ANOVA even for highly skewed non-normal distributions of small sample sizes (Norman, 2010), the original data was maintained. Outliers were also detected from the boxplots. To determine the way to deal with the outliers, analysis without the outliers were run and it turned out that the result were essentially the same, namely the statistically significant result and confidence intervals are not appreciably different from the result using original data, therefore the outliers were kept. According to the Levene's test of equality from each of the analyses, the assumptions of homogeneity of variances were violated to a certain extent for the data of each of the product, namely 11 out of 40 (Product 1), 7 out of 40 (Product 2), 4 out of 40 (Product 3) of the 'Sig.' values were greater than 0.05. However, because the ratio of the largest group variance (128) to the smallest group variance (65) was less than 3, the tests were run anyway by using the original data (Laerd Statistics 2016). The ANOVA were conducted to the data for each product respectively and the results are shown as follows:

5.4.1.1 Product 1 – bathroom scales

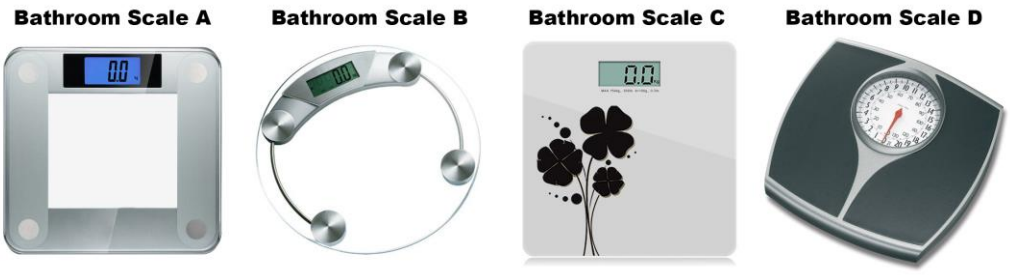


Figure 5.7 Product 1 — 4 types of bathroom scales that were used in the questionnaire

For the data of Product 1, Mauchly's test of sphericity (Table 5.9) indicated that the assumption of sphericity was violated, $\chi^2(2) = 1714.129$, $p < .001$; therefore the Greenhouse-Geisser correction factor to the degree of freedom of the test was applied. There was a statistically significant three-way interaction between products*aspects and cultural backgrounds, $F (14.2, 2719.5) = 5.800$, $p < .001$, partial $\eta^2 = .029$ (Table 5.10). The plots of three-way interaction (Figure 5.8)

visualized the differences in the interaction of the variables products*aspects between the ratings of UK and Chinese participants. Aspect 1 in the graph is the RRV and aspects 2 to 10 are the detailed aspects evaluated in the questionnaire (shown in the graph legend of Figure 5.8). From the plots it is clear that the ratings from the two groups of participants were significantly different on each aspects of each of the four products.

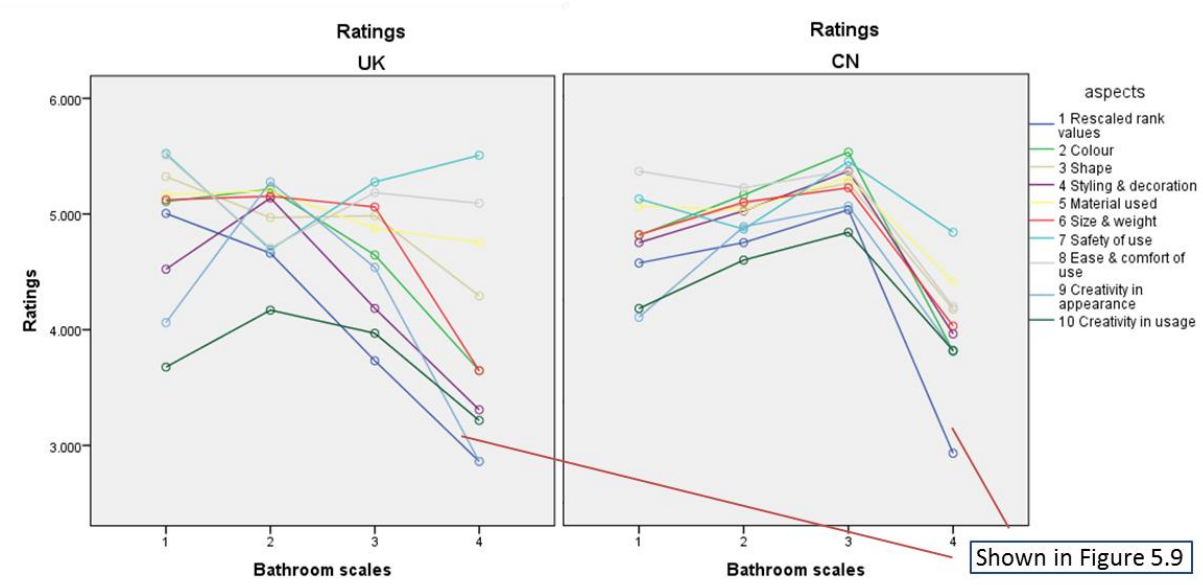


Figure 5.8 Plots of three-way interaction on bathroom scales from UK and Chinese participants

For the RRV (Figure 5.9), which indicate the overall judgements on the product, there were also significant differences: for UK participants the rank order of the products from the most to the least preferred one were P1, P2, P3 and P4; while for Chinese participants the order were P3, P2, P1 and P4. This result echoes with the finding in Study 1, which showed that UK and Chinese participants had differences in their overall evaluation on the excellence of a design. The specific role of each aspect in the overall judgments is investigated further in the next section.

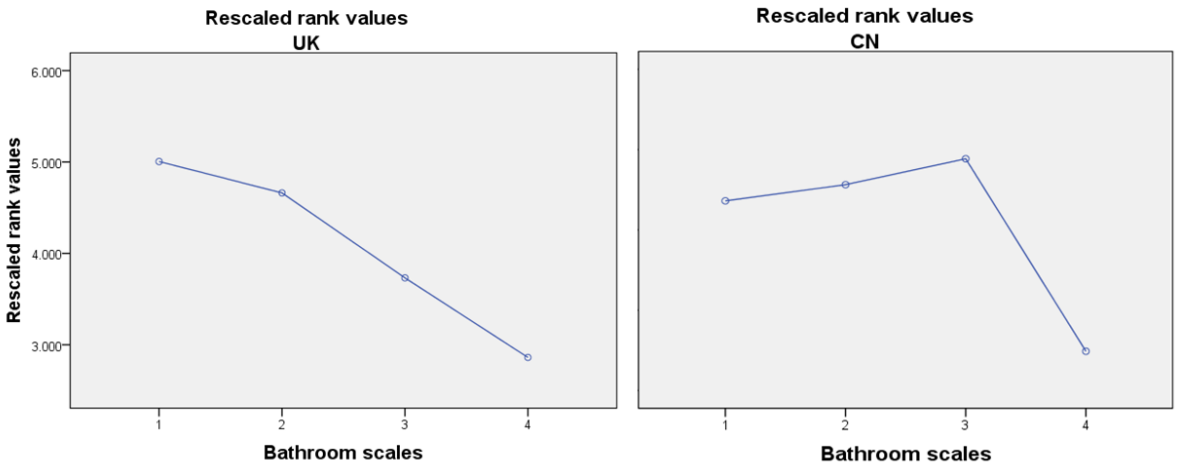


Figure 5.9 Rescaled rank values on bathroom scales from UK and Chinese participants

Table 5.9 Mauchly's Test of Sphericity[a] (Product 1)

Measure: ratings

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
products	.950	9.749	5	.083	.968	.990	.333
aspects	.087	458.546	44	.000	.582	.604	.111
products * aspects	.000	1714.129	377	.000	.527	.575	.037

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Nationality
Within Subjects Design: products + aspects + products * aspects

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Table 5.10 Tests of Within-Subjects Effects (Product 1)

Measure: ratings

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
products * aspects * Nationality	Sphericity Assumed	173.380	27	6.421	5.800	.000	.029
	Greenhouse-Geisser	173.380	14.238	12.177	5.800	.000	.029
	Huynh-Feldt	173.380	15.535	11.161	5.800	.000	.029
	Lower-bound	173.380	1.000	173.380	5.800	.017	.029
Error(products*aspects)	Sphericity Assumed	5709.144	5157	1.107			
	Greenhouse-Geisser	5709.144	2719.541	2.099			
	Huynh-Feldt	5709.144	2967.214	1.924			
	Lower-bound	5709.144	191.000	29.891			

5.4.1.2 Product 2 – kettles



Figure 5.10 Product 2 — 4 types of kettles that were used in the questionnaire

For the data of Product 2, Mauchly's test of sphericity (Table 5.11) indicated that the assumption of sphericity was violated, $\chi^2(2) = 2160.870$, $p < .001$; therefore the Greenhouse-Geisser correction factor to the degree of freedom of the test was applied. There was a statistically significant three-way interaction between products*aspects and cultural backgrounds, $F (12.7, 2430.4) = 3.033$, $p < .001$, partial $\eta^2 = .016$ (Table 5.11). The plots of three-way interaction (Figure 5.10) showed that there were significant differences between the ratings from the two groups. Aspect 1 in the graph is the RRV and aspects 2 to 10 are the detailed aspects evaluated in the questionnaire (shown in the graph legend of Figure 5.11). From the pattern of how the lines were arranged in the plots, it also shows some certain similarity. The specific role of each aspect in the overall judgments would be investigated further in the next section.

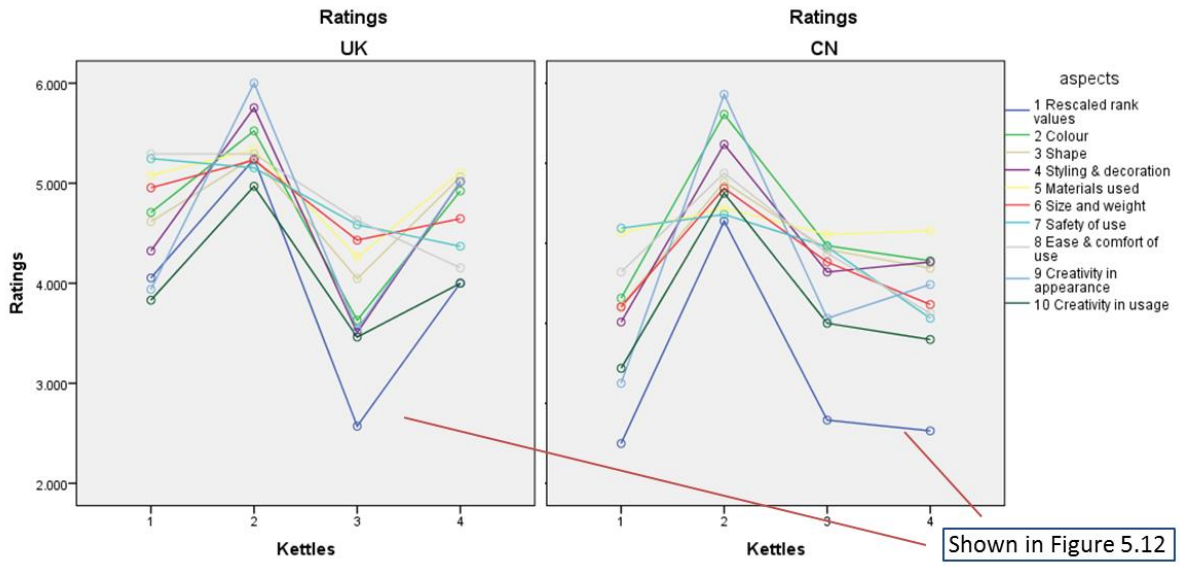


Figure 5.11 Plots of three-way interaction on kettles from UK and Chinese participants

From the point of view of the RRV significant differences were also found (Figure 5.12): the UK participants ranked the products from the most to the least preferred as the order of P2, P1, P4 and P3; the corresponding rank order for Chinese participants were P2, P3, P4, P1.

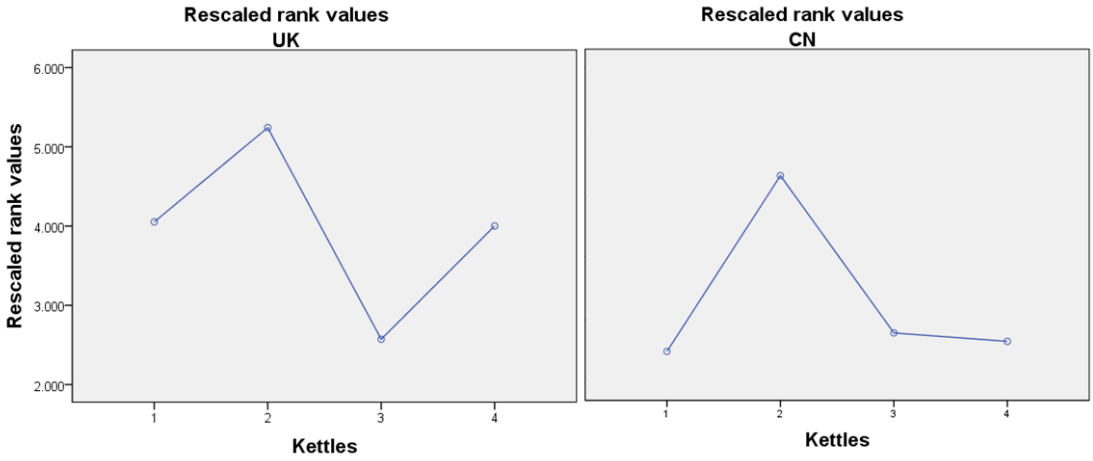


Figure 5.12 Rescaled rank values on kettles from UK and Chinese participants

Table 5.11 Mauchly's Test of Sphericity[a] (Product 2)

Mauchly's Test of Sphericity[a]

Measure: rating

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
products	.887	22.739	5	.000	.920	.940	.333
aspects	.106	421.313	44	.000	.675	.703	.111
products * aspects	.000	2160.870	377	.000	.471	.510	.037

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Nationality
Within Subjects Design: products + aspects + products * aspects

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Table 5.12 Tests of Within-Subjects Effects (Product 2)

Measure: ratings

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
products * aspects * Nationality	Sphericity Assumed	87.283	27	3.233	3.033	.000	.016
	Greenhouse-Geisser	87.283	12.725	6.859	3.033	.000	.016
	Huynh-Feldt	87.283	13.764	6.341	3.033	.000	.016
	Lower-bound	87.283	1.000	87.283	3.033	.083	.016
Error(products*aspects)	Sphericity Assumed	5495.833	5157	1.066			
	Greenhouse-Geisser	5495.833	2430.406	2.261			
	Huynh-Feldt	5495.833	2629.002	2.090			
	Lower-bound	5495.833	191.000	28.774			

5.4.1.3 Product 3 – computer mice



Figure 5.13 Product 3 — 4 types of computer mice that were used in the questionnaire

For the data of Product 2, Mauchly's test of sphericity (Table 5.13) indicated that the assumption of sphericity was violated, $\chi^2(2) = 2065.572$, $p < .001$; therefore the Greenhouse-Geisser correction factor to the degree of freedom of the test was applied. The three-way interaction between products*aspects and cultural backgrounds was not significant, $F(10.1, 1932.9) = 1.703$, $p = .074$, partial $\eta^2 = .009$ (Table 5.14), which means that the UK and Chinese participants showed no significant differences in the rating of the 4 types of computer mouse. From the plots of three-way interaction (Figure 5.12), it is also clear that pattern of the arrangement of the lines are similar with each other. . Aspect 1 in the graph is the RRV and aspects 2 to 9 are the detailed aspects evaluated in the questionnaire (shown in the graph legend of Figure 5.14).

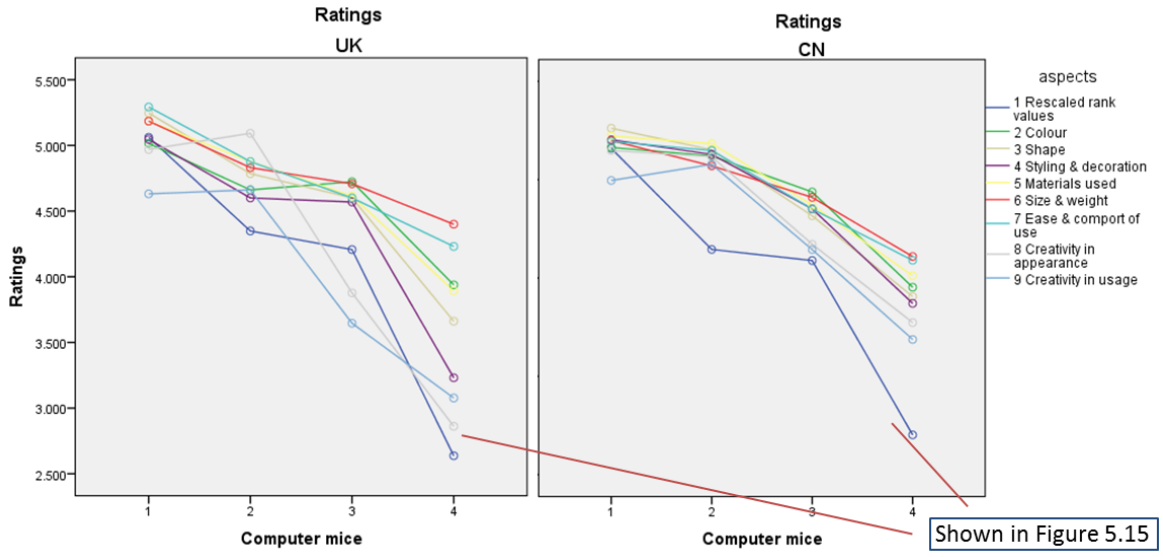


Figure 5.14 Plots of three-way interaction on computer mice from UK and Chinese participants

From the point of view of the rescaled rank values (Figure 5.15), it also shows a high similarity: for both groups of participants the products from the most to the least preferred as the order of P1, P2, P3 and P4, with very close ratings means.

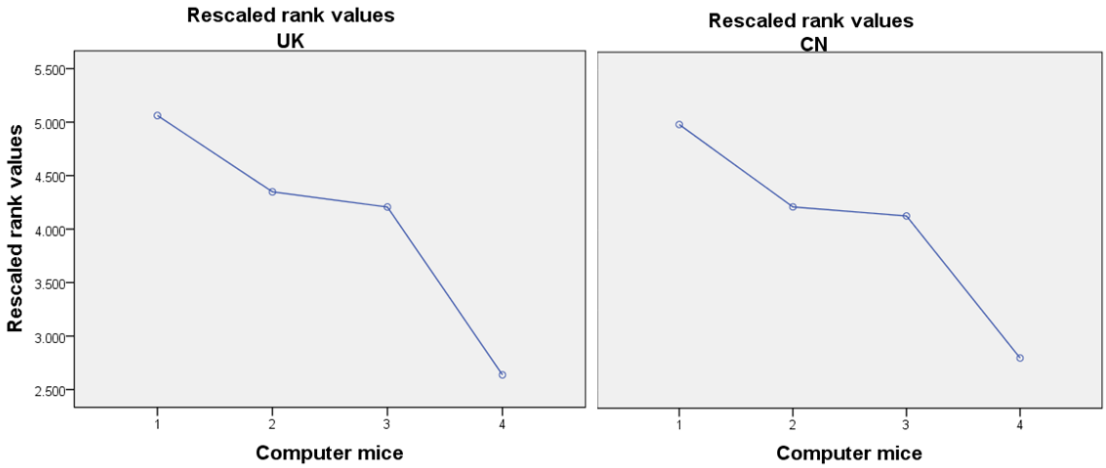


Figure 5.15 Rescaled rank values on kettles from UK and Chinese participants

Table 5.13 Mauchly's Test of Sphericity[a] (Product 3)

Measure: rating

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
products	.698	68.183	5	.000	.793	.808	.333
aspects	.056	540.819	35	.000	.577	.596	.125
products * aspects	.000	2065.572	299	.000	.422	.449	.042

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Nationality
Within Subjects Design: products + aspects + products * aspects

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Table 5.14 Tests of Within-Subjects Effects (Product 3)

Tests of Within-Subjects Effects

Measure: rating

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
products * aspects * Nationality	Sphericity Assumed	36.505	24	1.521	1.703	.018	.009
	Greenhouse-Geisser	36.505	10.120	3.607	1.703	.074	.009
	Huynh-Feldt	36.505	10.787	3.384	1.703	.068	.009
	Lower-bound	36.505	1.000	36.505	1.703	.193	.009
Error(products*aspects)	Sphericity Assumed	4093.547	4584	.893			
	Greenhouse-Geisser	4093.547	1932.898	2.118			
	Huynh-Feldt	4093.547	2060.300	1.987			
	Lower-bound	4093.547	191.000	21.432			

5.4.2 Analysis of the differences

From the results of the three-way mixed design ANOVA, it is clear that for Product 1 and Product 2, UK and Chinese participants showed significant differences in the ratings according to different aspects of different products. However, it is still uncertain how the individual components – the aspects of

aesthetics, ergonomics in utility and creativity – contributed to differences between the two groups in their appreciation of the designs. To specify the roles of different aspects in the overall design evaluation, hierarchical regression analyses were applied to the overall judgement (rescaled rank values, i.e. RRV) and ratings on all of the detailed aspects. According to the results of ANOVA, product type was also a significant variable on the performance of rating, therefore the multiple regression analyses were conducted on the data for each specific product. Based on the result of Study 1, both UK and Chinese people took aesthetics as the most important criteria in judging the excellence of design, therefore in the hierarchical regression analyses, the detailed criteria under the aspect of aesthetics (i.e. the colour, shape, styling & decoration and materials used) were added as the first set of variables, and the detailed criteria under ergonomics in utility (i.e. perceived size & weight, safety of use and ease & comfort of use) and creativity (i.e. creativity in appearance and usage) were added as the second and third set of variables to see how the addition would affect the prediction the overall judgements. Therefore for the models in the output, Model 1 presents only the aspect of aesthetics, Model 2 consists of aspects of aesthetics and ergonomics in utility, Model 3 consists of all the three aspects. The variables in each model were entered simultaneously (i.e., as the "Enter" method in SPSS). The results of the analyses of each product were presented below.

5.4.2.1 Product 1A

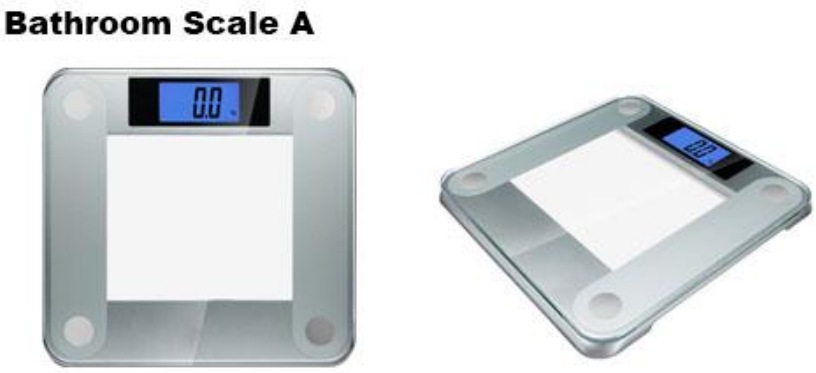


Figure 5.16 Bathroom scale A that was used in the questionnaire

UK group

The testing of the assumptions found 14 leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.15 shows the details of results of the hierarchical regression that was run to determine if the addition of aspects of in utility and then creativity improved the prediction of RRV over and above the aspects of aesthetics alone. The full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, $R^2 = .522$, F (9, 41) = 7.073, P < .001; adjusted $R^2 = .522$. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .007, F (3, 43) = 0.228, P = .877, which was not significant. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .026, F (2, 41) = 1.367, P = .266.

Table 5.15 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P1A UK

	Rescaled rank value								
	Model 1[a]			Model 2[b]			Model 3[c]		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	-3.02		0.01	-3.25		0.02	-3.17		0.02
Colour	0.44	0.27	0.09	0.42	0.26	0.13	0.49	0.30	0.08
Shape	0.84	0.50	0.00	0.74	0.44	0.01	0.81	0.48	0.00
Styling and decoration	-0.11	-0.08	0.63	-0.07	-0.05	0.79	0.11	0.09	0.68
Materials used	0.31	0.16	0.29	0.29	0.15	0.44	0.49	0.25	0.22
Perceived size and weight				0.21	0.11	0.44	0.10	0.06	0.71
Perceived safety of use				0.06	0.03	0.86	0.12	0.06	0.71
Perceived ease & comfort of use				-0.10	-0.06	0.80	-0.29	-0.16	0.47
Creativity in appearance							-0.23	-0.19	0.39
Creativity in usage							-0.14	-0.10	0.59
R^2	0.539			0.514			0.522		
F	15.589			8.557			7.073		
ΔR^2	0.575			0.007			0.026		
ΔF	15.589			0.228			1.367		

a. Predictors: (Constant), materials used, shape, colour, styling and decoration

b. Predictors: (Constant), materials used, shape, colour, styling and decoration, perceived safety of use, perceived ease & comfort of use, perceived size and weight

c. Predictors: (Constant), materials used, shape, colour, styling and decoration, perceived safety of use, perceived ease & comfort of use, perceived size and weight, creativity in usage, creativity in appearance

*The same hereinafter

CN group

The testing of the assumptions found one standardized residual value less than -3, one studentized deleted residual less than -3 and four leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.16 shows the details of results of the hierarchical regression that was run to determine if the addition of aspects of ergonomics in utility and then creativity improved the prediction of RRV over and above the aspects of aesthetics alone. The full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2 = .487, F (9, 112) = 11.826, P < .001; adjusted R^2 = .446. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to a significant increase in R^2 of .041, F (3, 114) = 2.972, P = .035. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .006, F (2, 112) = .677, P = .510.

Table 5.16 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P1A CN

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	-0.10		0.85	0.33		0.53	0.31		0.56
Colour	0.13	0.10	0.27	0.21	0.17	0.08	0.22	0.17	0.08
Shape	0.15	0.13	0.22	0.22	0.19	0.09	0.21	0.18	0.10
Styling and decoration	0.42	0.35	0.00	0.45	0.38	0.00	0.47	0.39	0.00
Materials used	0.26	0.20	0.02	0.52	0.40	0.00	0.54	0.42	0.00
Perceived size and weight				-0.13	-0.10	0.31	-0.14	-0.10	0.33
Perceived safety of use				-0.25	-0.21	0.06	-0.24	-0.20	0.07
Perceived ease & comfort of use				-0.12	-0.10	0.38	-0.12	-0.09	0.40
Creativity in appearance							0.15	0.13	0.38
Creativity in usage							-0.19	-0.17	0.25
R^2	0.440			0.481			0.487		
F	23.026			15.097			11.826		
ΔR^2	0.440			0.041			0.006		
ΔF	23.026			2.972			0.677		

5.4.2.2 Product 1B

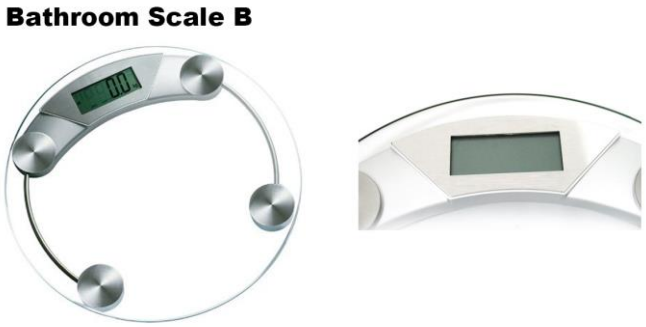


Figure 5.17 Bathroom scale B that was used in the questionnaire

UK group

The testing of the assumptions found 2 studentized deleted residual values less than -3 and 14 leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.17 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2 = .445, F (9, 39) = 3.470, P = .003; adjusted R^2 = .317. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .002, F (3, 41) = .050, P = .985, which was not significant. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .058, F (2, 39) = 2.049, P = .142.

Table 5.17 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P1B UK

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	2.00		0.06	2.02		0.09	3.23		0.02
Colour	-0.44	-0.30	0.12	-0.46	-0.32	0.14	-0.37	-0.26	0.22
Shape	0.08	0.07	0.76	0.11	0.09	0.71	0.45	0.39	0.19
Styling and decoration	1.01	0.77	0.01	0.97	0.74	0.02	0.95	0.73	0.03
Materials used	-0.09	-0.06	0.77	-0.09	-0.06	0.84	-0.08	-0.06	0.85
Perceived size and weight				-0.01	0.00	0.98	0.15	0.10	0.60
Perceived safety of use				-0.11	-0.09	0.77	-0.25	-0.21	0.49
Perceived ease & comfort of use				0.15	0.12	0.70	0.23	0.19	0.55
Creativity in appearance							-0.53	-0.34	0.13
Creativity in usage							-0.21	-0.16	0.30
R^2	0.384			0.386			0.445		
F	6.858			3.687			3.470		
ΔR^2	0.384			0.002			0.058		
ΔF	6.858			0.050			2.049		

CN group

The testing of the assumptions found one studentized deleted residual value greater than 3 and seven leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.18 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2 = .379, F (9, 110) = 7.467, P < .001; adjusted R^2 = .328. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .035, F (3, 112) = 2.039, P = .112, which is not significant. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .012, F (2, 110) = 1.035, P = .359.

Table 5.18 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P1B CN

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	B	β	Sig.	B	β	Sig.	B	β	Sig.
Constant	0.81		0.18	0.82		0.18	0.79		0.20
Colour	0.04	0.03	0.83	-0.11	-0.08	0.56	-0.12	-0.09	0.52
Shape	0.33	0.28	0.06	0.50	0.42	0.01	0.46	0.38	0.02
Styling and decoration	0.30	0.25	0.09	0.34	0.29	0.05	0.38	0.32	0.04
Materials used	0.09	0.07	0.57	0.25	0.18	0.18	0.25	0.18	0.19
Perceived size and weight				0.28	0.21	0.13	0.31	0.24	0.11
Perceived safety of use				-0.35	-0.29	0.05	-0.37	-0.31	0.04
Perceived ease & comfort of use				-0.18	-0.13	0.36	-0.15	-0.11	0.43
Creativity in appearance							0.23	0.21	0.18
Creativity in usage							-0.24	-0.20	0.20
R^2	0.333			0.368			0.379		
F	14.355			9.299			7.467		
ΔR^2	0.333			0.035			0.012		
ΔF	14.355			2.039			1.035		

5.4.2.3 Product 1C

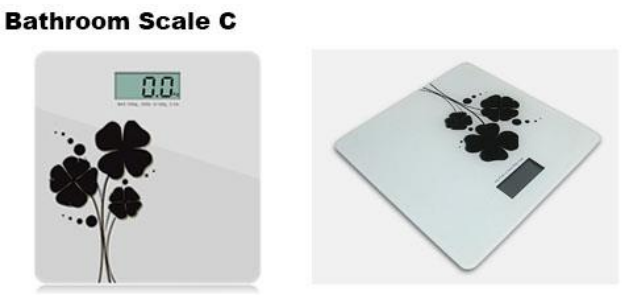


Figure 5.18 Bathroom scale C that was used in the questionnaire

UK group

The testing of the assumptions found 1 studentized deleted residual value more than 3 and 11 leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.19 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2=.544, F (9, 43) = 5.695, P < .001; adjusted R^2 = .448. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .034, F (3, 45) = 1.105, P=.357, which was not significant. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .010, F (2, 43) = .451, P = .640.

Table 5.19 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P1C UK

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	-1.18		-0.94	-0.19		-0.14	-0.04		0.98
Colour	-0.13	-0.08	-0.46	-0.06	-0.04	-0.22	0.02	0.02	0.94
Shape	0.12	0.06	0.49	0.15	0.07	0.50	0.16	0.08	0.60
Styling and decoration	0.88	0.68	3.81	0.83	0.65	3.58	1.01	0.78	0.00
Materials used	0.20	0.10	0.70	0.46	0.22	1.38	0.45	0.21	0.20
Perceived size and weight				-0.12	-0.05	-0.31	-0.10	-0.05	0.79
Perceived safety of use				-0.35	-0.18	-0.81	-0.37	-0.19	0.40
Perceived ease & comfort of use				-0.01	-0.01	-0.02	0.06	0.03	0.92
Creativity in appearance							-0.18	-0.13	0.58
Creativity in usage							-0.21	-0.12	0.48
R^2	0.500			0.534			0.544		
F	11.997			7.374			5.695		
ΔR^2	0.500			0.034			0.010		
ΔF	11.997			1.105			0.451		

CN group

The testing of the assumptions found seven leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.20 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2 = .298, F (9, 111) = 5.223, P < .001; adjusted R^2 = .241. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .004, F (3, 113) = .233,

P=.873, which was not significant. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .016, F (2, 111) = 1.251, P = .290.

Table 5.20 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P1C CN

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	0.50		0.55	0.31		0.73	0.11		0.90
Colour	0.19	0.12	0.40	0.20	0.13	0.38	0.18	0.11	0.43
Shape	-0.28	-0.17	0.22	-0.33	-0.20	0.21	-0.29	-0.17	0.28
Styling and decoration	0.81	0.51	0.00	0.80	0.50	0.00	0.69	0.43	0.01
Materials used	0.10	0.06	0.69	0.06	0.03	0.83	0.06	0.03	0.83
Perceived size and weight				0.16	0.09	0.54	0.11	0.07	0.68
Perceived safety of use				0.13	0.07	0.64	0.20	0.11	0.50
Perceived ease & comfort of use				-0.17	-0.10	0.58	-0.19	-0.11	0.53
Creativity in appearance							0.34	0.22	0.12
Creativity in usage							-0.21	-0.14	0.31
R^2	0.277			0.282			0.298		
F	11.123			6.330			5.223		
ΔR^2	0.277			0.004			0.016		
ΔF	11.123			0.233			1.251		

5.4.2.4 Product 1D



Figure 5.19 Bathroom scale D that was used in the questionnaire

UK group

The testing of the assumptions found 1 studentized deleted residual value more than 3 and 17 leverage values greater than 0.2 and therefore these cases were

excluded from the analysis. Table 5.21 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2=.446, F (9, 38) = 3.393, P = .004; adjusted R^2 = .283. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to a significant increase in R^2 of .208, F (3, 40) = 4.893, P = .005. The addition of creativity to the prediction of RRV (Model 3) led to a not significant increase in R^2 of .012, F (2, 38) = 0.408, P = .668.

Table 5.21 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P1D UK

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	-0.60		0.57	-0.25		-0.24	-0.11		0.92
Colour	0.48	0.30	0.34	1.05	0.65	2.19	1.04	0.65	0.04
Shape	-0.17	-0.10	0.67	-0.52	-0.31	-1.35	-0.56	-0.34	0.16
Styling and decoration	0.09	0.06	0.81	-0.12	-0.08	-0.36	-0.12	-0.08	0.78
Materials used	0.40	0.26	0.21	0.25	0.16	0.78	0.23	0.15	0.50
Perceived size and weight				0.16	0.09	0.57	0.16	0.09	0.61
Perceived safety of use				-1.33	-0.92	-3.34	-1.29	-0.90	0.00
Perceived ease & comfort of use				1.39	0.97	3.30	1.42	0.99	0.00
Creativity in appearance							0.38	0.22	0.49
Creativity in usage							-0.40	-0.23	0.39
R^2	0.226			0.434			0.446		
F	3.136			4.375			3.393		
ΔR^2	0.226			0.208			0.012		
ΔF	3.136			4.893			0.408		

CN group

The testing of the assumptions found 1 studentized deleted residual value more than 3 and 8 leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.22 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2 = .217, F (9, 110) = 3.397, P = .001; adjusted R^2 = .153. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to a significant increase in R^2 of .041, F (3, 112) = 3.342, P = .022. The addition

of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .024, F (2, 110) = 1.700, P = .187.

Table 5.22 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P1D CN

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	1.15		0.04	1.44		0.02	1.40		0.02
Colour	0.47	0.34	0.03	0.52	0.38	0.02	0.51	0.37	0.02
Shape	0.03	0.02	0.89	-0.06	-0.04	0.82	-0.01	0.00	0.98
Styling and decoration	0.18	0.13	0.45	0.03	0.02	0.89	0.07	0.05	0.78
Materials used	-0.28	-0.21	0.12	-0.30	-0.23	0.11	-0.30	-0.23	0.12
Perceived size and weight				-0.30	-0.20	0.11	-0.34	-0.23	0.07
Perceived safety of use				-0.17	-0.13	0.30	-0.18	-0.13	0.27
Perceived ease & comfort of use				0.62	0.45	0.00	0.64	0.47	0.01
Creativity in appearance							-0.40	-0.31	0.08
Creativity in usage							0.35	0.26	0.15
R^2	0.121			0.193			0.217		
F	3.962			3.834			3.397		
ΔR^2	0.121			0.072			0.024		
ΔF	3.962			3.342			1.700		

5.4.2.5 Product 2A



Figure 5.20 Kettle A that was used in the questionnaire

UK group

Table 5.23 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R2 = .274, F (9, 55) = 2.306, P = .028; adjusted R^2 = .015. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .002, F (3, 57) = .054, P = .983, which was not significant. The addition of

creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .015, F (2, 55) = .562, P = .573.

Table 5.23 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P2A UK

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	1.65		0.07	1.77		0.11	1.87		0.10
Colour	-0.23	-0.19	0.31	-0.23	-0.18	0.36	-0.23	-0.18	0.37
Shape	0.17	0.14	0.51	0.19	0.15	0.51	0.19	0.15	0.51
Styling and decoration	0.56	0.48	0.04	0.55	0.47	0.05	0.41	0.35	0.19
Materials used	0.05	0.04	0.83	0.07	0.05	0.81	0.02	0.02	0.94
Perceived size and weight				0.04	0.03	0.87	-0.05	-0.03	0.87
Perceived safety of use				0.06	0.04	0.86	0.07	0.05	0.85
Perceived ease & comfort of use				-0.14	-0.09	0.72	-0.12	-0.08	0.75
Creativity in appearance							0.20	0.18	0.46
Creativity in usage							0.05	0.04	0.81
R^2	0.257			0.259			0.274		
F	5.189			2.848			2.306		
ΔR^2	0.257			0.002			0.015		
ΔF	5.189			0.054			0.562		

CN group

The testing of the assumptions found 1 studentized deleted residual value more than 3 and 9 leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.24 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2 = .323, F (9, 108) = 5.729, P < .001; adjusted R^2 = .267. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .001, F (3, 110) = 0.030, P = .993, which was not significant. The addition of creativity to the prediction of RRV (Model 3) led to a significant increase in R^2 of .048, F (2, 108) = 3.818, P = .025.

Table 5.24 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P2A CN

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	0.40		0.52	0.44		0.52	0.18		0.79
Colour	-0.07	-0.05	0.77	-0.05	-0.04	0.83	-0.12	-0.09	0.62
Shape	0.72	0.56	0.02	0.73	0.56	0.02	0.54	0.42	0.09

Styling and decoration	-0.08	-0.06	0.79	-0.07	-0.05	0.82	-0.20	-0.14	0.52
Materials used	0.11	0.08	0.61	0.14	0.09	0.58	0.16	0.11	0.50
Perceived size and weight				-0.04	-0.03	0.85	-0.14	-0.10	0.49
Perceived safety of use				0.01	0.00	0.98	0.10	0.07	0.63
Perceived ease & comfort of use				-0.03	-0.02	0.88	0.00	0.00	0.99
Creativity in appearance							0.62	0.48	0.02
Creativity in usage							-0.20	-0.16	0.43
R^2	0.275			0.275			0.323		
F	10.699			5.969			5.729		
ΔR^2	0.275			0.001			0.048		
ΔF	10.699			0.030			3.818		

5.4.2.6 Product 2B



Figure 5.21 Kettle B that was used in the questionnaire

UK group

The testing of the assumptions found 2 studentized deleted residual values greater than ±3 and 13 leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.25 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2 = .482, F (9, 41) = 4.231, P = 0.001; adjusted R^2 = .368. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .027, F (3, 43) = .672, P = .574, which was not significant. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .055, F (2, 41) = 2.185, P = .125.

Table 5.25 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P2B UK

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	-0.38		0.81	0.01		0.99	-0.49		0.80
Colour	0.91	0.57	0.01	0.99	0.62	0.00	1.10	0.69	0.00
Shape	0.07	0.03	0.83	0.23	0.11	0.49	0.05	0.02	0.90
Styling and decoration	0.27	0.14	0.45	0.31	0.16	0.40	-0.27	-0.15	0.60
Materials used	-0.22	-0.11	0.55	-0.06	-0.03	0.89	-0.43	-0.21	0.33
Perceived size and weight				-0.26	-0.11	0.51	-0.24	-0.11	0.53
Perceived safety of use				0.27	0.14	0.49	0.15	0.08	0.70
Perceived ease & comfort of use				-0.52	-0.27	0.22	-0.36	-0.19	0.40
Creativity in appearance							0.69	0.32	0.18
Creativity in usage							0.33	0.23	0.26
R^2	0.399			0.426			0.482		
F	7.646			4.564			4.231		
ΔR^2	0.399			0.027			0.055		
ΔF	7.646			0.672			2.185		

CN group

The testing of the assumptions found eight leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.26 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2 = .307, F (9, 110) = 5.408, P < .001; adjusted R^2 = .250. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .007, F (3, 112) = 0.339, P = .797, which was not significant. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .022, F (2, 110) = 1.763, P = .176.

Table 5.26 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P2B CN

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	-0.30		0.74	-0.28		0.76	-0.80		0.39
Colour	0.80	0.47	0.01	0.76	0.45	0.01	0.66	0.38	0.03
Shape	-0.12	-0.07	0.62	-0.14	-0.08	0.58	-0.27	-0.16	0.33
Styling and decoration	0.10	0.06	0.70	0.15	0.09	0.59	0.07	0.04	0.81
Materials used	0.18	0.10	0.39	0.29	0.16	0.28	0.23	0.13	0.38
Perceived size and weight				0.16	0.09	0.54	0.07	0.04	0.80
Perceived safety of use				-0.18	-0.11	0.44	-0.07	-0.04	0.78
Perceived ease & comfort of use				-0.08	-0.05	0.79	-0.19	-0.11	0.53

Creativity in appearance			0.39	0.22	0.11
Creativity in usage			0.14	0.08	0.57
R^2	0.278	0.285	0.307		
F	11.070	6.362	5.408		
ΔR^2	0.278	0.007	0.022		
ΔF	11.070	0.339	1.763		

5.4.2.7 Product 2C

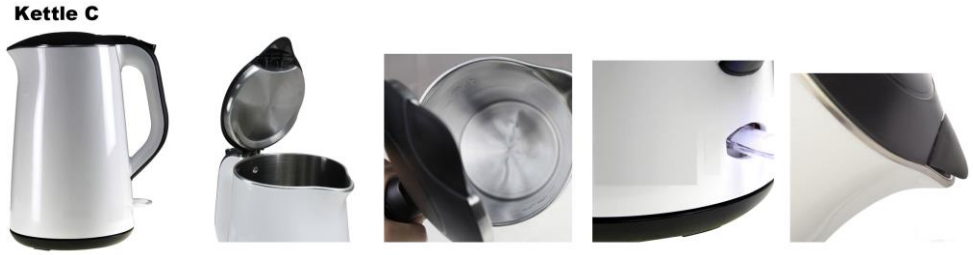


Figure 5.22 Kettle C that was used in the questionnaire

UK group

The testing of the assumptions found 1 studentized deleted residual value greater than 3 and 15 leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.27 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2 = .371, F (9, 39) = 2.557, P = 0.020; adjusted R^2 = .226. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .043, F (3, 41) = .880, P = .459, which was not significant. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .031, F (2, 39) = .962, P = .391.

Table 5.27 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P2C UK

	Rescaled rank value								
	Model 1			**Model 2**			**Model 3**		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	1.13		0.19	0.93		0.32	1.00		0.29
Colour	0.89	0.75	0.02	1.02	0.86	0.01	0.84	0.71	0.05
Shape	-0.35	-0.28	0.31	-0.49	-0.39	0.18	-0.54	-0.43	0.14
Styling and decoration	0.15	0.12	0.68	0.02	0.02	0.96	-0.01	0.00	0.99
Materials used	-0.27	-0.19	0.38	-0.29	-0.20	0.42	-0.27	-0.18	0.45
Perceived size and weight				0.15	0.11	0.63	-0.05	-0.04	0.88
Perceived safety of use				-0.75	-0.61	0.20	-0.49	-0.40	0.43
Perceived ease & comfort of use				0.80	0.63	0.22	0.51	0.40	0.46

Creativity in appearance				0.20	0.16	0.63
Creativity in usage				0.32	0.23	0.47
R^2	0.298		0.340	0.371		
F	4.660		3.019	2.557		
ΔR^2	0.298		0.043	0.031		
ΔF	4.660		0.880	0.962		

CN group

The testing of the assumptions found seven leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.28 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2 = .176, F (9, 111) = 2.633, P = .008; adjusted R^2 = .109. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .003, F (3, 113) = 0.154, P = .927, which was not significant. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .002, F (2, 111) = .130, P = .878.

Table 5.28 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P2C CN

	Rescaled rank value								
	Model 1			**Model 2**			**Model 3**		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	0.33		0.66	0.11		0.90	0.17		0.85
Colour	0.19	0.13	0.45	0.20	0.14	0.43	0.17	0.11	0.55
Shape	0.04	0.03	0.87	-0.01	-0.01	0.96	-0.02	-0.01	0.95
Styling and decoration	0.13	0.09	0.63	0.10	0.07	0.71	0.12	0.08	0.70
Materials used	0.33	0.20	0.21	0.27	0.16	0.36	0.27	0.16	0.36
Perceived size and weight				0.09	0.06	0.71	0.07	0.04	0.78
Perceived safety of use				0.01	0.01	0.97	0.02	0.01	0.95
Perceived ease & comfort of use				0.08	0.05	0.77	0.08	0.05	0.77
Creativity in appearance							0.12	0.08	0.64
Creativity in usage							-0.10	-0.07	0.67
R^2	0.171			0.174			0.176		
F	5.966			3.400			2.633		
ΔR^2	0.171			0.003			0.002		
ΔF	5.966			0.154			0.130		

5.4.2.8 Product 2D



Figure 5.23 Kettle D that was used in the questionnaire

UK group

The testing of the assumptions found 15 leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.29 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, $R^2 = .621$, $F (9, 40) = 7.282$, $P < 0.001$; adjusted $R^2 = .536$. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to an increase in R^2 of .034, $F (3, 42) = 1.106$, $P = .357$, which was not significant. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .051, $F (2, 40) = 2.689$, $P = .080$.

Table 5.29 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P2D UK

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	-1.06		0.38	-0.73		0.55	-0.91		0.44
Colour	-0.05	-0.03	0.89	-0.11	-0.07	0.73	0.11	0.07	0.73
Shape	0.88	0.58	0.00	0.96	0.63	0.00	0.95	0.62	0.00
Styling and decoration	0.62	0.36	0.14	0.55	0.32	0.20	0.63	0.37	0.13
Materials used	-0.47	-0.21	0.26	-0.25	-0.11	0.57	0.09	0.04	0.83
Perceived size and weight				-0.28	-0.16	0.35	-0.42	-0.24	0.16
Perceived safety of use				-0.52	-0.34	0.22	-0.31	-0.21	0.46
Perceived ease & comfort of use				0.57	0.39	0.18	0.50	0.34	0.23
Creativity in appearance							-0.28	-0.17	0.40
Creativity in usage							-0.36	-0.26	0.08
R^2	0.536			0.570			0.621		
F	12.999			7.954			7.282		
ΔR^2	0.536			0.034			0.051		
ΔF	12.999			1.106			2.689		

CN group

The testing of the assumptions found one studentized deleted residual value greater than 3 and seven leverage values greater than 0.2 and therefore these cases were excluded from the analysis. Table 5.30 shows that the full model of aspects of aesthetics, ergonomics in utility and creativity to predict rescaled rank value was statistically significant, R^2 = .346, F (9, 118) = 6.929, P < 0.001; adjusted R^2 = .296. The addition of ergonomics in utility aspect to the prediction of RRV (Model 2) led to a significant increase in R^2 of .050, F (3, 120) = 3.061, P = .031. The addition of creativity to the prediction of RRV (Model 3) also led to a not significant increase in R^2 of .001, F (2, 118) = .123, P = .885.

Table 5.30 Hierarchical multiple regression predicting RRV from the aspects of aesthetics, ergonomics in utility, creativity – P2D CN

	Rescaled rank value								
	Model 1			Model 2			Model 3		
Variable	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Constant	-0.04		0.96	-0.23		0.74	-0.21		0.77
Colour	0.27	0.17	0.14	0.34	0.22	0.08	0.32	0.20	0.11
Shape	0.45	0.30	0.03	0.39	0.26	0.06	0.38	0.25	0.08
Styling and decoration	0.47	0.30	0.03	0.35	0.23	0.09	0.36	0.23	0.13
Materials used	-0.38	-0.23	0.07	-0.49	-0.30	0.03	-0.50	-0.30	0.03
Perceived size and weight				-0.28	-0.18	0.12	-0.26	-0.17	0.16
Perceived safety of use				0.35	0.23	0.04	0.35	0.23	0.04
Perceived ease & comfort of use				0.22	0.14	0.26	0.25	0.16	0.22
Creativity in appearance							0.08	0.05	0.71
Creativity in usage							-0.09	-0.06	0.65
R^2	0.294			0.344			0.346		
F	12.819			9.005			6.929		
ΔR^2	0.294			0.050			0.001		
ΔF	12.819			3.061			0.123		

5.4.2.9 Differences in the multiple regression models between UK and Chinese groups

The multiple regression models shown in Table 5.15 – 5.30 reveal some differences in the two groups' evaluation on the provided products. Table 5.31 summaries the Beta values generated from the Hierarchical multiple regression analyses.

Table 5.31 Beta values from the multiple regression models of each product of UK and Chinese participants

		Aesthetics				Perceived ergonomics			Creativity	
		Colour	Shape	Styling & decoration	Materials used	Size & weight	Safety of use	Ease & comfort of use	Appearance	Usage
UK	**1A**	0.3	0.48**	0.09	0.25	0.06	0.06	-0.16	-0.19	-0.1
	1B	-0.26	0.39	0.73*	-0.06	0.1	-0.21	0.19	-0.34	-0.16
	1C	0.02	0.08	0.78**	0.21	-0.05	-0.19	0.03	-0.13	-0.12
	1D	0.65*	-0.34	-0.08	0.15	0.09	-0.9**	0.99**	0.22	-0.23
	2A	-0.18	0.15	0.35	0.02	-0.03	0.05	-0.08	0.18	0.04
	2B	0.69**	0.02	-0.15	-0.21	-0.11	0.08	-0.19	0.32	0.23
	2C	0.71*	-0.43	0	-0.18	-0.04	-0.4	0.4	0.16	0.23
	2D	0.07	0.62*	0.37	0.04	-0.24	-0.21	0.34	-0.17	-0.26
CN	**1A**	0.17	0.18	0.39**	0.42**	-0.1	-0.2	-0.09	0.13	-0.17
	1B	-0.09	0.38*	0.32*	0.18	0.24	-0.31*	-0.11	0.21	-0.2
	1C	0.11	-0.17	0.43*	0.03	0.07	0.11	-0.11	0.22	-0.14
	1D	0.37*	0	0.05	-0.23	-0.23	-0.13	0.47*	-0.31	0.26
	2A	-0.09	0.42	-0.14	0.11	-0.1	0.07	0	0.48*	-0.16
	2B	0.38*	-0.16	0.04	0.13	0.04	-0.04	-0.11	0.22	0.08
	2C	0.11	-0.01	0.08	0.16	0.04	0.01	0.05	0.08	-0.07
	2D	0.2	0.25	0.23	-0.3*	-0.17	0.23*	0.16	0.05	-0.06

*Note. *p<.05, **p<.001*

First of all, from the point of view of the hierarchical design of the regression models, the results show that, for the UK group, only the model for the Product 1D did the aspect of ergonomics in utility play a significant role in the prediction of the overall evaluation. For the Chinese group, the addition of the aspect of ergonomics in utility was significant for three of the products (1A, 1D and 2D). Also, as shown in Table 5.31, if the statistically significant beta value of aesthetics from the UK groups (0.48, 0.73, 0.78, 0.65, 0.69, 0.71, 0.62) and those from the Chinese group (0.39, 0.42, 0.38, 0.32, 0.43, 0.37, 0.38, -.03) are compared, it is easy to see that the UK participants tended to put more importance on the aesthetics compared to their Chinese counterparts. This result echoes with the finding in Study 1 that, for design evaluation, the UK participants tended to value more on aesthetics compared to Chinese participants.

To visualise the data, the Beta values were divided into different levels of weighting as shown in Table 5.32: the $0 < \text{Beta} \leq 0.2$ were defined as low positive

weighting, 0.2 < Beta ≤ 0.4 were defined as medium positive weighting, 0.4 < Beta < 1 were defined as high positive weighting; on the contrary, -0.2 ≤ Beta < 0 were defined as low negative weighting, -0.4 ≤ Beta < 0.2 were defined as medium negative weighting, -1 < Beta < 0.4 were defined as high negative weighting. By referring to both the statistically significant values together with the weighting references, in general, the UK group tended to have different emphases on the three aspects: with the aesthetics as the most important criterion, followed with ergonomics and then creativity; whereas for the Chinese group, relatively equal weightings were attributed to the three aspects, with slightly more emphasis on the aesthetics.

For the detailed criteria in evaluating aesthetics, the two groups showed considerable differences: for the UK group, colour is the most important criterion in judging aesthetics, with three high weighting and also statistically significant Beta values, followed by shape and styling & decoration, with two statistically significant and high weighting Beta values (for shape there was also a negative weighting Beta value). Material is the least relevant element when judging aesthetics. For the Chinese group, it seems that the four detailed aspects shared quite equal weighting, with quite close weighting values with statistically significance.

For the aspect of perceived ergonomics in utility, the two groups showed quite moderate preferences. The UK group put more value on this aspect compared to the Chinese group: the perceived ease and comfort of use is one of the most valued elements, with one very high weighting and statistically significant Beta value and two medium positive weighting; The safety of use was also a quite important criterion but a relatively complicated one, as there were one very high and three medium negative weighting Beta value. The Chinese group had one relatively high weighting and statistically significant Beta value on the criteria of perceived ease & comfort of use, and also two medium weighting values on the aspect of the safety of use, one positive and one negative.

Table 5.32 Weighting of Beta values from multiple regression models of each product of UK and Chinese participants

		Aesthetics				Perceived ergonomics			Creativity	
		Colour	Shape	Styling & decoration	Materials used	Size & weight	Safety of use	Ease & comfort of use	Appearance	Usage
UK	1A	0.3	0.48**	0.09	0.25	0.06	0.06	-0.16	-0.19	-0.1
	1B	-0.26	0.39	0.73*	-0.06	0.1	-0.21	0.19	-0.34	-0.16
	1C	0.02	0.08	0.78**	0.21	-0.05	-0.19	0.03	-0.13	-0.12
	1D	0.65*	-0.34	-0.08	0.15	0.09	-0.9**	0.99**	0.22	-0.23
	2A	-0.18	0.15	0.35	0.02	-0.03	0.05	-0.08	0.18	0.04
	2B	0.69**	0.02	-0.15	-0.21	-0.11	0.08	-0.19	0.32	0.23
	2C	0.71*	-0.43	0	-0.18	-0.04	-0.4	0.4	0.16	0.23
	2D	0.07	0.62*	0.37	0.04	-0.24	-0.21	0.34	-0.17	-0.26
CN	1A	0.17	0.18	0.39**	0.42**	-0.1	-0.2	-0.09	0.13	-0.17
	1B	-0.09	0.38*	0.32*	0.18	0.24	-0.31*	-0.11	0.21	-0.2
	1C	0.11	-0.17	0.43*	0.03	0.07	0.11	-0.11	0.22	-0.14
	1D	0.37*	0	0.05	-0.23	-0.23	-0.13	0.47*	-0.31	0.26
	2A	-0.09	0.42	-0.14	0.11	-0.1	0.07	0	0.48*	-0.16
	2B	0.38*	-0.16	0.04	0.13	0.04	-0.04	-0.11	0.22	0.08
	2C	0.11	-0.01	0.08	0.16	0.04	0.01	0.05	0.08	-0.07
	2D	0.2	0.25	0.23	-0.3*	-0.17	0.23*	0.16	0.05	-0.06

Note.

Beta	Colour
(0.4, 1)	
(0.2, 0.4]	
(0, 0.2]	
[-0.2, 0)	
[-0.4, -0.2)	
(-1, -0.4)	

Creativity was the least appreciated aspect by the UK group, with no high weighting Beta value. Whereas the Chinese group tended to weight creativity in appearance more than in usage compared to their UK counterparts.

Based on the interpretation above, a more general equation that predicates UK / Chinese people's judgement on product could be concluded as follows:

UK:

Predict judgement = constant x + a_1 x **colour + a_2** x **styling & decoration + a_3** x **shape + b1** x **ease & comfort of use + b_2** x **safety + c_1** x **material + c_2** x **creativity in usage + c_3** x **creativity in appearance**

Note. ***|a| > |b| > |c|***

CN:

Predict judgement = constant x + a_1 x styling & decoration + a_2 x material + a_3 x ease & comfort of use + a_4 x creativity in appearance + b_1 x colour + b_2 x shape + b_3 x safety of use

Note. ***|a| > |b|***

By forming the equations into the research model, the UK and Chinese outcomes from the online design evaluation can be presented as in Figure 5.21 & 5.22 respectively (the deeper the colour, the greater the influence from the specific element on the overall evaluation).

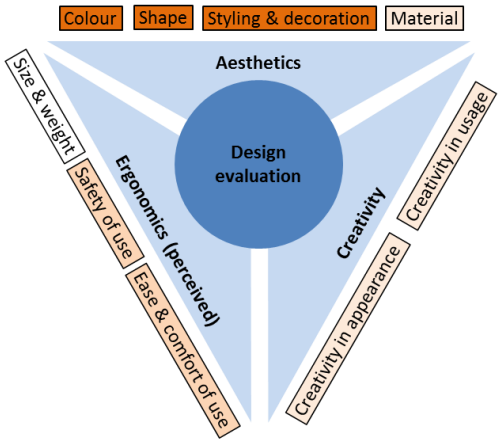


Figure 5.24 Aspects of importance identified in the UK online design evaluation[5]

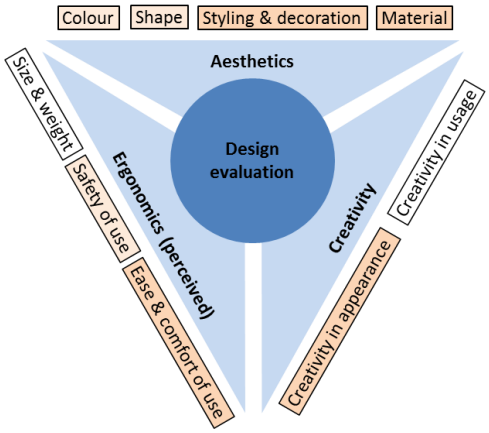


Figure 5.25 Aspects of importance identified in the Chinese way of online design evaluation

[5] The deeper the colour, the greater the influence from the specific element on the overall evaluation.

5.5 Discussion

5.5.1 The role of culture in different types of products

The three-way ANOVA results confirmed that, with a larger and random sample, there are differences in the evaluation of the selected bathroom scales and kettles between UK and Chinese people. It indicates that culture plays a significant role in the appreciation of aesthetics, perceived ergonomics in utility and creativity in these two types of products.

For the product of computer mouse, no significant differences were found in the two groups' evaluation. If the three products are compared in detail, some different attributes would be brought in to attention. Bathroom scales and kettles are closely related to daily life and also have a relative long history in common life use: they are bigger in size, have relatively more straightforward functions and are also easier to perceive their usage; whereas a computer mouse is related to modern technology: it has limited size and shape and its usage and functionality are vaguer and depend more on user experience. These characteristics of the computer mouse have probably made it more difficult to distinguish the differences in the evaluation. Actually this result also agrees the result from Tihanyi, et al. (2005), who found a negative relationship between cultural distance and international diversification for high-technology industries. On the other hand, the reality in the market of these products also to some extent confirms the result. The products that are related to high technology are selling globally with more justification to the design according to different culture. Whilst the household products like bathroom scales and kettles were mostly designed and sold domestically. It could be another interesting topic to explore the cultural difference in the using of high technology related products.

5.5.2 Aesthetics vs. ergonomics & creativity

The findings validated parts of the results of Study 1: 1) they validated that there are significant differences in the criteria of design evaluation between the UK and the Chinese groups; 2) they agreed that the UK general public consider the aesthetics as the most important criterion, and usability and creativity the

second and third respectively; 3) the results from the Chinese participants were slightly different from Study 1, in which aesthetics and ergonomics tended to be equally valued, with slightly more emphasis on the aesthetics rather than focused more on the ergonomics aspect. The differences in the three aspects were also explored in further detail using the hierarchy multiple regression (excluding the data of the products of computer mouse). The hierarchy design of multiple regression analysis also examined the weighting of these three aspects in the overall evaluation. According to the significane values of the models, except for the ergonomics in the models of Product 1D of the UK group and Product 1A, 1D and 2D of the Chinese group, also the creativity in the model of Product 2A of the Chinese group, the addition of these two variables did not lead to any statistically significant difference to the regression model.

From an overall point of view, aesthetics were the most important criteria for both of the two groups, especially for the UK group. From the literature, aesthetics has a significant impact on the evaluation of designs, not only because it is the main means of presenting the whole design idea but also because it is highly related to other aspects such as ergonomics and usability (Cyr et al. 2006; Quinn & Tran 2010). The correlation data between all the variables from this study also showed that aesthetics was highly related to creativity. Take the data of Product 1B from UK group as an example, Table 5.33 shows that there were high correlation among the **creativity in appearance** and the variables of **aesthetics**, i.e. **colour** ($r = 0.524$, $p < 0.001$), **shape** ($r = 0.803$, $p < 0.001$), **styling & decoration**($r = 0.705$, $p < 0.001$), **material** ($r = 0.581$, $p < 0.001$). The correlations among other variables were also quite high (but there was no multicollinearity as they were all less than 0.9 (Field 2013), which suggested that the aspects of aesthetics, ergonomics and creativity were related with each other. Further research could explore the relationships among the three aspects.

Table 5.33 Correlation among the variables – Product 1B - UK

		RRV	Co	Sh	SD	MU	SW	SU	EC	CA	CU
RRV	Pearson Correlation	1									
	Sig. (2-tailed)										
	N	49									
Colour	Pearson Correlation	0.24	1								
	Sig. (2-tailed)	0.09									
	N	49	49								
Shape	Pearson Correlation	.534**	.492**	1							
	Sig. (2-tailed)	0.00	0.00								
	N	49	49	49							
Styling & decoration	Pearson Correlation	.570**	.717**	.840**	1						
	Sig. (2-tailed)	0.00	0.00	0.00							
	N	49	49	49	49						
Materials used	Pearson Correlation	.353*	.717**	.635**	.756**	1					
	Sig. (2-tailed)	0.01	0.00	0.00	0.00						
	N	49	49	49	49	49					
Size & weight	Pearson Correlation	0.28	.564**	.475**	.601**	.736**	1				
	Sig. (2-tailed)	0.05	0.00	0.00	0.00	0.00					
	N	49	49	49	49	49	49				
Safety of use	Pearson Correlation	0.24	.431**	.383**	.497**	.758**	.603**	1			
	Sig. (2-tailed)	0.10	0.00	0.01	0.00	0.00	0.00				
	N	49	49	49	49	49	49	49			
Ease & comfort of use	Pearson Correlation	.291*	.573**	.410**	.598**	.773**	.611**	.889**	1		
	Sig. (2-tailed)	0.04	0.00	0.00	0.00	0.00	0.00	0.00			
	N	49	49	49	49	49	49	49	49		
Creativity in appearance	Pearson Correlation	.294*	.524**	.803**	.705**	.581**	.514**	.293*	.346*	1	
	Sig. (2-tailed)	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.01		
	N	49	49	49	49	49	49	49	49	49	49
Creativity in usage	Pearson Correlation	0.18	.415**	.483**	.539**	.394**	.410**	0.21	.335*	.500**	1
	Sig. (2-tailed)	0.20	0.00	0.00	0.00	0.01	0.00	0.15	0.02	0.00	
	N	49	49	49	49	49	49	49	49	49	49

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

5.5.3 The statistical significance of the equations

The two equations based on the analysis of Beta values from multiple regressions give an overall view of the two groups of participants evaluating the presented bathroom scales and kettles. It clearly presents the differences between the UK and Chinese groups, not only in terms of the detailed variables of aesthetics, ergonomics and creativity, but also from the overall evaluation. One thing to notice here is that, although all the models of each product from each group were statistically significant, the Beta values of each variable were not necessary at a statistically significant level (refer to Table 5.15 – 5.30). The two equations were generated based on statistical significance values together with the weighting reference, rather than simply abstracted from significant data. The multiple repression models were interpreted in this way so as to get an overall view of the roles of all the detailed criteria in the model. The prediction of the overall evaluation was complicated, as it is not only attributed to a few significant variables but actually the combined action of all the variables. It is the first time in design studies that the cultural differences in judging design attributes have been presented in such a clear and straightforward way. However, it is also worthy noting that they were generated at a relatively abstract level and would be only applicable in a general sense. Further studies could be conducted to examine the differences suggested by the two equations using different products.

5.5.4 Representativeness of the sample

According to Figure 5.4 and 5.5, there were more participants under the age of 30 and also with lower income in the Chinese group compared to the UK group. This kind of phenomenon agreed with the real situation of internet use in these two countries. According to the Statistical Report on Internet Development in China (CINIC 2015), about 55% of internet users are under the age of 30. Whereas the data from the Office for National Statistics in UK (OFNS 2015) shows that almost all adults aged 16-54 years use the internet at a very high frequency. The differences in the demographic information of people in these two countries should be taken into consideration when matching the samples.

On the other hand, the correlation between age and design appreciation is still a topic that need to be investigated. Lähteenmäki & Kaikkonen (2004) proposed that although older users are often treated as a homogenous group in the area of design, the reality is that they are as hetergeneous as users in any other age range. Therefore, it is sound to say that, although there were some differences in the perspectives of age and correspondingly in incomes, the sample was representative of online users from the respective culture.

5.5.5 The using and design of online questionnaire

The advantage of using an online questionnaire is that it is possible to collect data with a relevantly large sample in a low cost and less time-consuming way. However, it also has flaws that could influence the results in a negative way. Firstly, the level of the detail of questions was limited due to the format of online questionnaire, especially for investigation on the aspect of ergonomics in utility. It was only evaluated at a subjective and visual level rather, but left out the objective aspects (Fulton Suri & Marsh 2000; Han et al. 2000). Secondly, some of the data may have not represented the real intention of the participants, which could be attributed to the objective reasons such as the insufficiency of information when answering specific questions or misunderstanding the questions, or subjective reasons such as laziness or reluctance to finish the questionnaire. The outliers found in the assumption tests of statistical analyses were partly due to improperly finished questionnaires. If it was permitted, questionnaires in person would be a more appropriate way to collect more sufficient and accurate information.

The converting of the rank values to an interval scale was a time-consuming task in this study. The conversion method used was not an existing complete solution but rather a combination of several steps from different methods. The initial intention of using rank values instead of ratings was to prevent some iterative ratings on the overall judgment question, which could lead to invalid data. This problem also exposes the disadvantage of conducting an online questionnaire with relatively complicated questions.

5.6 Conclusion

This study has validated the results of Study 1 and show, with large sample, that there are differences between UK and Chinese people's judgment on design outcomes. Using three-way ANOVA analyses, a significant influence of culture on the interaction of products*aspects between the ratings of UK and Chinese participants was confirmed. It also explored the differences in the aspects of aesthetics, ergonomics in utility and creativity at a more detailed level. By using multiple regression analyses, the weighting of the specific criteria of each aspect was identified and equations and models were generated to predict the overall judgement on products from UK and Chinese people. In general, UK people tended to pay more attention to the aesthetics aspect compared, whereas Chinese people tended to put relatively moderate weighting on all the three aspects. This study was conducted from the perspective of the outcome of design activity. Further studies would be applied to investigate the role of culture in the process of design.

6 CULTURAL DIFFERENCES IN THE DESIGN PROCESS – A STUDY OF DESIGN STUDENTS

6.1 Chapter overview

This chapter presents a study with student designers from the UK and China. The study developed a research model based on two existing design models from the literature review to investigate the differences shown in the design processes from the design problem to the design solution. There were two main sections of this study, an ethnographic observation in a design studio on the students' daily design activities and a coding analysis on their design submissions. The results revealed differences from two perspectives: 1. The two groups of student designers had different understanding of the using of sketching as a tool in design: the UK participants tended to use the sketches as a tool for developing as well as recording ideas; 2. They showed different cognitive processes from the design problem to the design solution. It also revealed the differences shown in the design process that concerns the features of aesthetics, ergonomics and creativity.

6.2 Introduction

Study 1 and 2 compared the cultural differences from the perspective of design outcomes. The following parts of this PhD research investigated the differences from the perspective of the design process. This chapter reports a longitudinal study of design students from the Course of Product Design and Manufacture (PDM) of the University of Nottingham. It compared the design processes of the UK and Chinese student designers.

As mentioned in section 1.2, Type II studies, which investigate the relationship between culture and the design process, have revealed that culture play an important role in the design process. Razzaghi et al. (2009) found that culture impacts on the patterns of design ideas. Choe's (2004) study showed that Korean and Australian firms tended to provide information in different amounts and also

with different focuses in the design of the information system. Chueng-Nainby (2010) in her study found that the Chinese designer showed different ways of communication during early design collaboration with Western designers. However, there is limited research that addresses the cultural influences from the perspective of the implicit design cognitions during the design process. On the other hand, there was also quite a lot of research that was concerned with design cognition in the design process (Lloyd et al. 1995; Suwa & Tversky 1997; Dorst & Cross 2001; Fish & Scrivener 2014), but the comparison of the design process of designers from different cultures is still an area that has been hardly studied. The present study set out to address the gaps between the two areas.

Since the beginning of the present PhD research, the researcher has spent a lot of time together with the students in Product Design and Manufacture, either in a class or in the design studio where most of their design activities took place. The close interactions with the students had allowed the opportunities of close observation of their design activities. Interesting differences were captured both from the perspectives of the explicit cultural pattern and the implicit cognitive process. The present study aimed to investigate the potential differences statistically and systemically.

6.2.1 Background and research model

As the person who put forward the rational problem solving theory, Simon (1996) described the design process as “the search for a solution through a vast maze of possibilities”. As introduced in Section 2.1.2, whether it is from the theory of rationalism or descriptivism, Dubberly et al. (2004 cited by Chueng-Nainby 2010) introduced a design model that consists of the basic process of ‘problem-to-solution’ (Figure 6.1). With the design problem as the input and a design solution as the outcome, the whole design process takes this basis as a basic unit and expands it to larger models that rarely have fixed beginnings and endings (Dubberly 2008) (Figure 6.2). The undefined beginning and ending of a design process echoes with the theory of descriptivism based on the idea of reflective practice (Schön 1991) and situated cognition (Suchman 1987). The presented

study focused on the cognitive differences that were shown in the complete process from the moment the designers got the design task to the presentation of their final designs. In order to compare the differences in a more structured way, the map from the RIBA Architectural Practice and Management Handbook (1965, cited by Lawson 2006) introduces in section 2.1.2 was also used as a basis for the research model in this study (Figure 6.3).

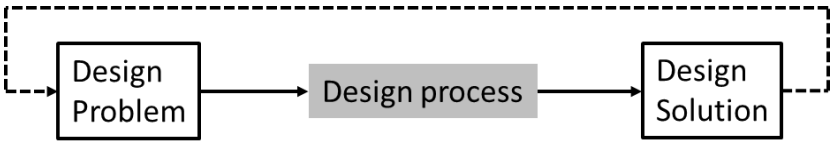


Figure 6.1 The early stage of designing (Dubberly et al, 2004 cited by Chueng-Nainby 2010)

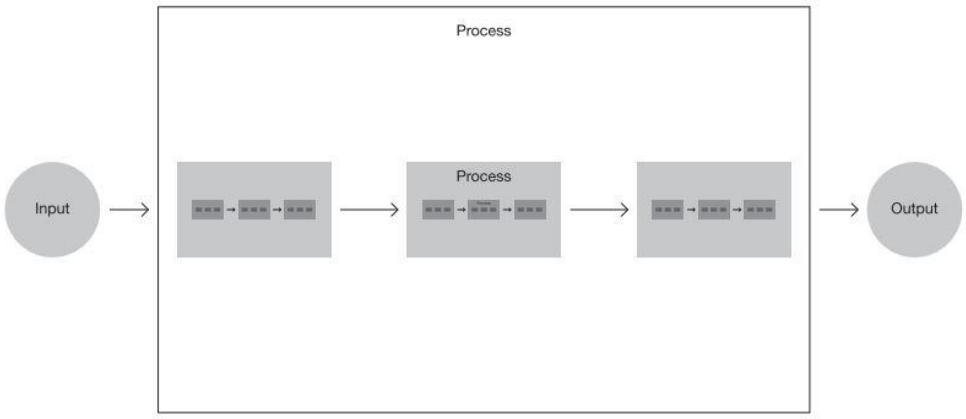


Figure 6.2 The infinite expandability of processes models, adopted from (Dubberly 2008)

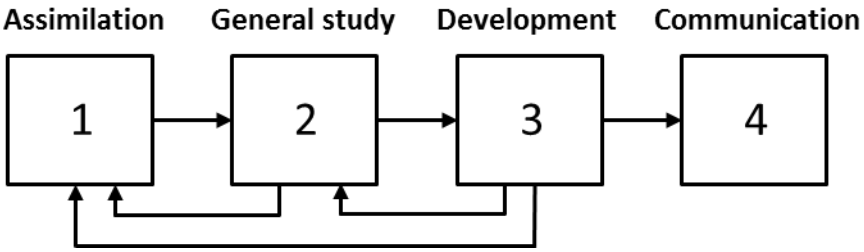


Figure 6.3 A map of the design process from Architectural Practice and Management Handbook (1965, cited by Lawson 2006)

In this map (Figure 6.3), the Phase 1 of Assimilation was defined as "the accumulation and ordering of general information and information specifically related to the problem in hand" and Phase 2 as "the investigation of the nature

of the problem and the investigation of possible solutions or means of solution". In general, design could be perceived as a process that starts from a problem and ends with a solution. In a real situation, rather than accepting a 'given problem', it usually starts from 'finding' appropriate problems (Cross 1999). The first two phases in the map refer to the process of formulating the 'problem', and this formulation is also accompanied by the search for possible solutions (Cross 1999; Lawson 2006). A distinct separation between the two phases does not necessarily exist. Lawson (Lawson 2006) also pointed out that for the designers, it is very difficult to know what information to collect in phase 1 until they have investigated the problem more closely in phase 2. Therefore in this study the model was adjusted as follows:

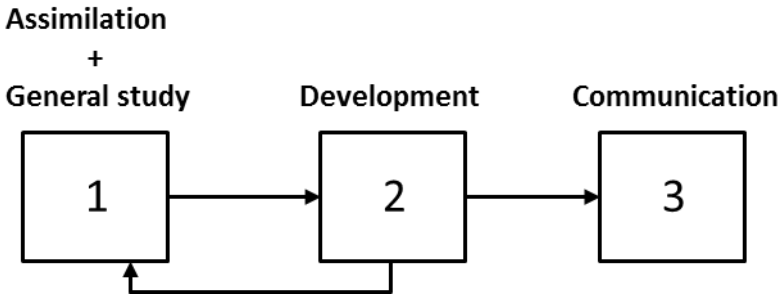


Figure 6.4 An adjusted map of the design process

The definitions of these phases are as below:

Table 6.1 Definition of phases in the design process (Architectural Practice and Management Handbook, 1965 cited by Lawson 2006)

Phase 1 **assimilation + general study**	The accumulation and ordering of general information and information specifically related to the problem in hand. The investigation of the nature of the problem. The investigation of possible solutions or means of solution.
Phase 2 **development**	The development and refinement of one or more of the tentative solutions isolated during phase 1.
Phase 3 **Communication**	The communication of one or more solutions to people inside or outside the design team.

The present study combined two models shown in Figure 6.1 & 6.4 to interpret the process from a design problem to a design solution. Basically, the three phases from the RIBA Architectural Practice and Management Handbook (1965 cited by Lawson 2006) were used as the basic structure of design procedure along which the cognitive process from problem to solution took place.

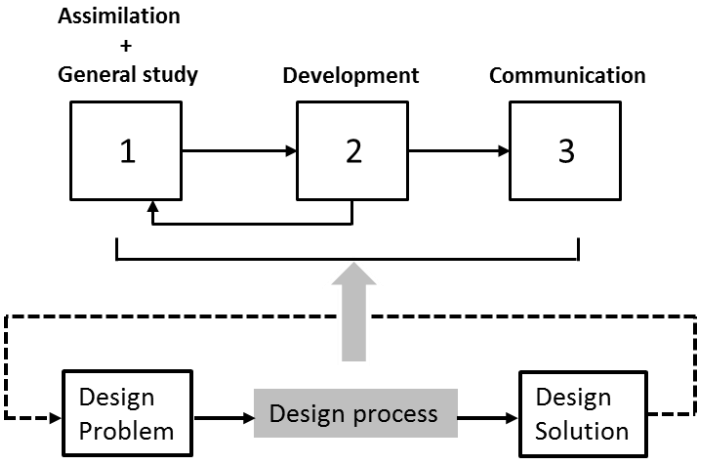


Figure 6.5 Research model of design process for Study 3

6.2.2 Aim and objectives

The overall aim of this study was to investigate the differences in the design process of the student designers of UK or Chinese cultural backgrounds. The specific objectives were as follows:

- To investigate the cognitive differences in the design process shown in the collected design submissions between UK and Chinese student designers, i.e. how do they conduct the process from formulating design problems to generating design solutions?
- To investigate the specific patterns shown in the design process between the two groups in their ways of addressing the design attributes in the aspects of aesthetics, ergonomics and creativity in their design process.
- To interpret the reasons for any differences identified.

6.2.3 Hypotheses of study

Based on the ethnographic observation in the design studio, which was the first section of this study, the Hypotheses on the differences in the design processes were drawn as follows:

1. The Chinese students tend to show less information in their sketches compared to their UK counterparts,
2. The Chinese and UK students tend to use the tools of sketches in different ways,
3. The differences shown in the design processes of '2+2' (Chinese) students tend to decrease as time went by.

6.3 Method

6.3.1 Samples of student designers

The participants of this study were 2nd year students (BEng) in Product Design and Manufacture (PDM) of the University of Nottingham. They consisted of three different samples:

1. **UK students (UK)**: who had done their first year in the UK campus and would continue with their following two years there;
2. **'2+2' Chinese students ('2+2')**: who had spent their first two years in the Ningbo (China) campus (the first was for language study) and would continue their following two years in the UK campus together with the UK students.
3. **Ningbo Chinese students (CN)**: who did their first two years in the Ningbo (China) Campus (the first was for language study) and would continue with their following two years in the Ningbo campus.

Technically speaking, they were at the same stage of progress in Product design study using the same learning material and education system[6]. The present study lasted from September 2014 to March 2015, through two academic semesters of

[6] The students in PDM course of the University of Nottingham have the opportunity in their 2nd year to take the same education in whichever campus of the university.

the participants' (equivalent) 2nd academic year (excluding the language only year). During the period of this study, the students went through four design projects that were required to be finished individually. The first project took place at the beginning of the autumn semester 2014 and was also the first formal design task in their study of product design, as Year 1 concerns mainly engineering fundamentals. The fourth project took place at the beginning of the spring semester 2015. The recruitment was announced in the class at the beginning of the 2nd academic year, when the '2+2' Chinese students had newly arrived in the UK. Six of the Chinese students (3 male and 3 female) aged from 20 to 21 (Mean = 20.33, SD = 0.52) and 11 UK students (5 male and 6 female) aged from 19 to 20 (Mean = 19.55, SD = 0.52) were recruited from the UK campus. In Ningbo campus, 6 Chinese students (3 male and 3 female) were recruited, with ages ranging from 18 to 21 (Mean = 20.33, SD = 1.21).

The study was designed based on the relevant ethical principles and has been reviewed according to the ethical review processes in place at the University of Nottingham, Faculty of Engineering, and also the Ningbo campus. The relevant participant information sheets and consent forms can be found in Appendix 6A.

6.3.2 Study setting and data collection

The present study mainly took place in the UK campus of the University of Nottingham and consisted of two sections. Table 6.2 shows the situation of each group involved in each section.

Table 6.2 Groups involved in each section

	UK	**'2+2'**	**CN**
Section 1	Yes	Yes	No
Section 2	Yes	Yes	Yes

Section 1 consisted of ethnographic observation in the main design studio in the UK campus where the students did most of their design activities every Monday and Thursday mornings throughout term time. Only participants from the UK campus (i.e. the '2+2' Chinese group and the UK group) were involved in this

section. The observation started from September 2014 to March 2015. It was conducted in the traditional way of ethnographic studies, with the researcher sitting in the studio observing the design activities of the participants and taking notes (Atkinson & Hammersley 1994). The participants were told about the purpose of the observation before it took place. Sometimes the researcher also interviewed the participants with a few questions (such as "What is the consideration of this sketch?", "What stage are you in the design task now?", etc. The students were also asked about their experience in sketching, interests in design, etc. during their spare time in the studio.), but the basic principle was to do the observation in an objective way, without subjective influence on the participants' natural activity. Data in this section was mainly acquired from the notes taken from the design studio that were based on the observation and small talk with the participants. Figure 6.6 shows the interior of the main design studio and Figure 6.7 were pictures taken when the students were designing.

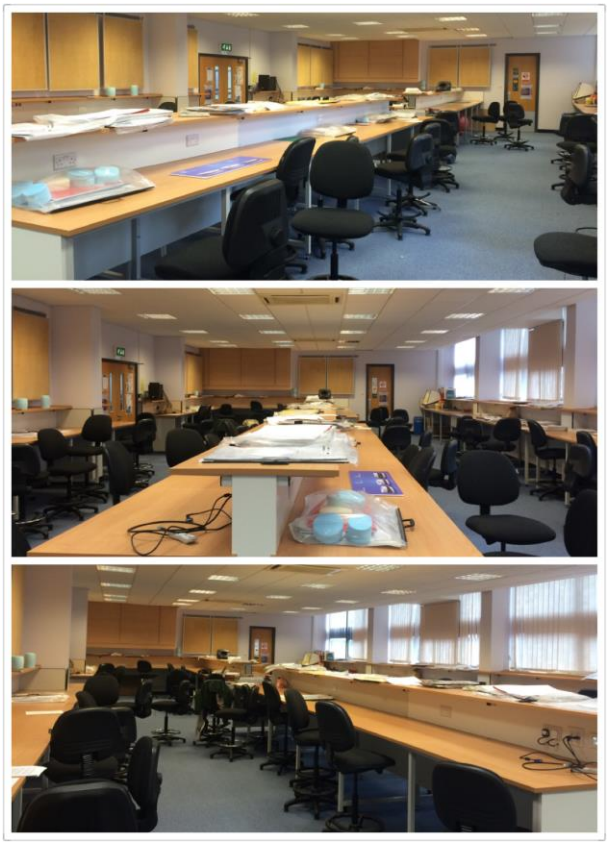


Figure 6.6 The interior of the main design studio



Figure 6.7 Pictures taken from the design studio when the students were designing

Section 2 involved content analysis on the design submissions in their 1st and 4th design task, which took place at the beginning of the first semester and the second semester respectively. All three groups of participants took part in this section. There were two parts to the analyses in this section: 1. A coding analysis on the submissions, to investigate the cognitive differences shown in the whole design process; 2. A semantic word cloud analysis on the transcriptions of design submissions to investigate the specific way they formulating the design process.

The reports they submitted for the first and fourth projects were collected, transcribed and coded by the researcher.

For the students in the UK campus, the 1st and 4th design task were about **garden lighting** and a **broadband filter** respectively. The design briefs stated the tasks as follows:

Garden lighting:

You are asked to design decorative outdoor lighting to be used in gardens and play areas. The lighting will need to complement and provide a visual enhancement to a garden style of your choice.

You will need to consider the shape and form of the lighting product and have a working knowledge of the component parts and how it works. Consider how the garden is used and by whom. How might the lighting be designed to enhance garden usage? What issues need to be considered when designing a lighting unit? Importantly, what will differentiate your design from others on the market?

Your design need not be pared back to the minimum for cost savings but you will have to justify strong product benefits for high complexity and costs.

You should research existing products and the way that users interact with these products. Through your research, find out and list all the needs and requirements for the product. Identify three of these requirements that you feel are most important and that you will focus on with your design.

Broadband filter:

You are asked to design a broadband filter (DSL or Microfilter). The device is for domestic use in homes. It connects between the phone socket and the broadband router. The device reduces interference between the analogue phone signals and the digital signals for the internet connection.

The device is a common sight in homes yet little attention has been paid to its appearance. Most users have no choice about the use of the product, it is a requirement of their internet connection.

The design should not be a licence product i.e. be tied to a character, film/book or brand. It should be suitable for modern homes and should be something people want to see not the like the current functional only box.

In the design of the product you are asked to consider the following:

- Where the unit will be placed in a home.
- What is an appropriate form for the product
- What are appropriate colours and finishes for the product
- The construction and assembly of the unit.

You need to take a fresh approach to the design of this product. Using product semantics to help define the products form you are expected to create a design that conveys the purpose of the product and provide a visual link to its function in its form and/or the products detail.

As well as the exterior form, you are expected to consider the insides of your product and to detail the way the unit is constructed and fits together. Your Pro/E model should be complete in as much detail as you can achieve.

The design tasks used in the Ningbo campus were different from the ones in the UK campus, which were about a **children's outdoor toy** and a **baby monitor** respectively. It was based on the consideration of the different living environments of the students from these two campuses, but they were with close design attributes and the same requirements. Therefore the comparison among the three groups of participant was applicable. The design briefs of the two design tasks stated as follows:

Children's outdoor toy:

You are asked to design a children's outdoor toy to be used in gardens and play areas. The toy will need to appeal to children between the ages of 6 – 9 years of age. The toy can be designed for use by one child or by a group of children playing together.

You will need to consider the user and his/her specific needs. How do children like to play, what activities do they enjoy and what issues need to be considered when designing for children. Importantly, what will differentiate your design from others on the market?

Your design need not be pared back to the minimum for cost savings but you will have to justify strong product benefits for high complexity and costs.

You should research existing products and the way that users interact with these products*. Through your research, find out and list all the needs and requirements for the product. Identify three of these requirements that you feel are most important and that you will focus on with your design.

Baby monitor:

You are asked to design a sound only Baby monitor for listening to a baby/child whilst sleeping. For the purpose of this project you have to design the transmitter and the receiver.

The unit should be able to be powered by batteries and mains power. It should be relatively small – a hand held unit size. It needs a power indicator, a power switch and a microphone.

The design should not be a licence product i.e. be tied to a character or film/book. It should be suitable for modern homes and promote a soft caring image.

> In the design of the product you are asked to consider the following:
>
> • how the monitor will be positioned in the room
>
> • how the unit will be interacted with by adults
>
> • the construction and assembly of the unit
>
> You need to take a fresh approach to the design of this product. Using product semantics to help define the products form you are expected to create a design that conveys the purpose of the product and provide a visual link to its function in its form and/or detail.
>
> As well as the exterior form, you are expected to consider the insides of your product and to detail the way the unit is constructed and fits together. Your Creo model should be complete in as much detail as you can achieve.

The briefs also indicated the requirements for the reports that were submitted as coursework which would be marked by the course tutors. Basically they were required to submit all design work including the sketches, layouts, research and mock-ups/rigs, final design visuals, drawing showing the size and dimensions, presentation boards (in Project 4 also a Pro-E model which in the Ningbo campus was a Creo model). A small difference here was that, in the UK campus, the number of the presentation boards was four which was not compulsory for students in the Ningbo campus. It makes the presentation parts different in the submissions from the two campuses.

The data from the students in the UK campus was collected by the researcher photographing all the reports that were submitted by the students. The students in the Ningbo campus were asked to submit digital copies of their work and these digital copies were collected as their data.

6.3.3 Coding of design process

6.3.3.1 Division and transcription of the design submissions

The objects of the coding process were the design submissions that were collected from the participants. In order to code the design submission more systematically, it was necessary to transcribe all the material into information units and make it applicable for coding in NVivo 10. There were three basic elements in the submissions, i.e. sketches, texts and pictures (see Figure 6.8). The basic principle of the transcription was to define each small independent area

that was shown in a sheet as one unit. Therefore one unit here could be single sketch, picture or text; it could also be a sketch with the relevant text or a picture with the relevant text. Figure 6.9 shows the transcription of this specific sheet: first of all, the whole sheet would be selected and transcribed as “sketches sheet 9 – detailed development”, then four main areas were divided and transcribed as sketch 1, sketch 2, sketch 3 and sketch 4, with the text showing in the relevant area. The process of division and transcription was conducted in NVivo 10. In total there were 1548 pages of data collected from all the submissions in design project 1 and project 4. They were divided into 8564 units.

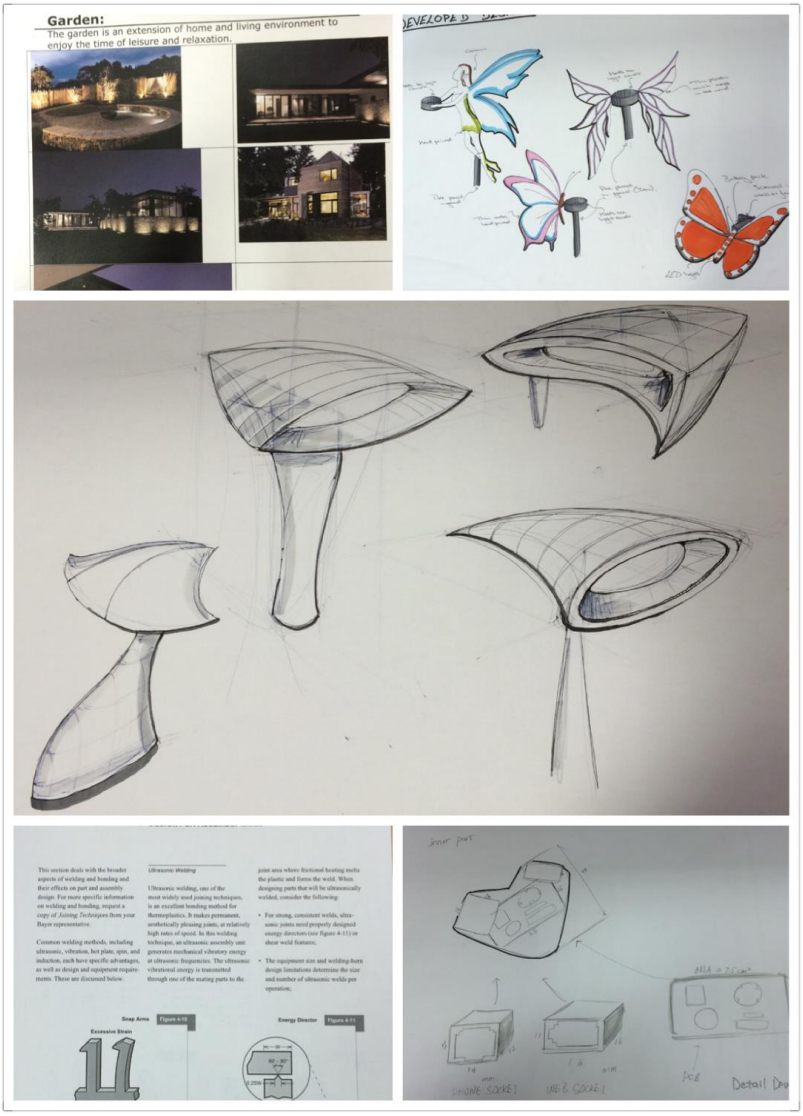
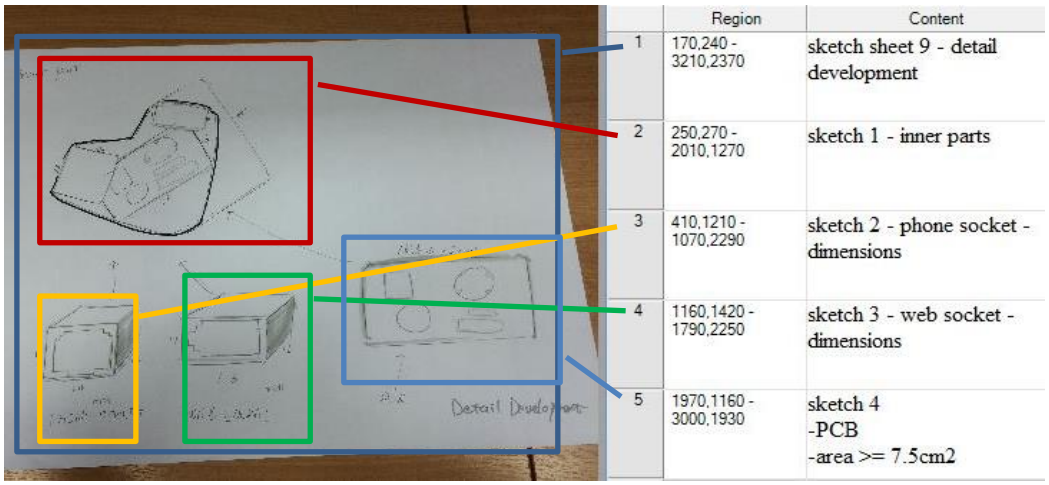


Figure 6.8 Example sheets of the students’ submissions



	Region	Content
1	170,240 - 3210,2370	sketch sheet 9 - detail development
2	250,270 - 2010,1270	sketch 1 - inner parts
3	410,1210 - 1070,2290	sketch 2 - phone socket - dimensions
4	1160,1420 - 1790,2250	sketch 3 - web socket - dimensions
5	1970,1160 - 3000,1930	sketch 4 -PCB -area >= 7.5cm2

Figure 6.9 An example of division process 2

6.3.3.2 Structure of the coding system

The coding system was developed based on the adjusted map of design process from Architectural Practice and Management Handbook (Figure 6.2). The design process was divided into three phases, i.e. assimilation + general study, development and communication. Then, based on grounded theory that a design process is actually a journey from a problem to a solution (Simon 1996; Chueng-Nainby 2010; Dubberly 2008) and that problems and solutions are always emerging together rather than one following consequently upon the other (Lawson 2006), the detailed content shown in each phase as the information presented by the designer was coded into the units of 'problem', 'solution', 'problem + solution'. The detailed coding system was as follows:

Table 6.3 Coding model of design process

1 Assimilation + general study	problem
	problem + solution
	solution
	undefined
2 Development	problem
	problem + solution
	solution
	undefined
3 Communication	problem
	problem + solution
	solution
	undefined

Although the coding system simplified the cognitive structure throughout the design process with the three basic units of 'problem', 'solution', 'problem + solution', the contents of each unit varied in each phase. As mentioned above, in the actual design process, the problem and solution are always emerging together and the splitting between them does not necessarily exist. The essence of coding was to judge whether the presented information is more close to the problem end or the solution end and this kind of judgement was always quite subjective. Based on the observation in the design studio and relevant literature reviews, the general judging criteria were concluded as below (Table 6.4).

Table 6.4 Definition of the codes in each Phase

1 Assimilation + general study	Problem	Passively collect or display existing information Examples: user centred: target user listing or describing, etc.; product centred: such as existing product listing, using environment listing; unpacking the brief, analysing the requirements and constraints
	Problem + solution	Proactively analysing, thinking etc., involving the possible means to solution Examples: relating to aesthetics (colour, shape, decoration), ergonomics (safety, comfort, ease, size and dimensions, usage, duration), functionality, materials, how it works, etc.
	Solution	Investigating possible solutions Examples: Single sketch without any text, inspiration, mood board
	Undefined	Not related to any item above
2 Development	Problem	Questions arose during the development of ideas (with text of questions or question mark)
	Problem + solution	Sketch with text / text only
	Solution	Sketches of design ideas or of things that are associated with design ideas
	Undefined	Not related to any item above
3 Communication	Problem	Any questions arose at this stage
	Problem + solution	Final design with illustration of using, size, scale, scenario of using
	Solution	The final design
	Undefined	Not related to any item above

The phase of **Assimilation + general** study generally referred to the stage of information research before any design idea actually emerged. At this stage, the

designers have searched information to formulate the design problem. The information they collected and showed in the submissions could normally be categorised as user centred ones and product centred ones. The former always presented as target user research, which could be the selection of a specific user group, the analysis of this target group and personal research (appeared in Project 4 from Chinese students in Ningbo campus only). As this specific content is essential to the formulation of the design problem, they would be categorised into the 'problem' code. For the product centred research, there could be existing product research and when the information presented was only picture collection of an existing product (which was very common in the submissions from UK students) it would be coded as 'problem', but when it was also together with analysing text referring to the advantages and disadvantages of these products, it would be coded as 'problem + solution'. There was another big portion in the product centred research that was about the specific aspects of the possible solution, such as the material, manufacture, ergonomics etc., this type of information would be coded as 'problem + solution', as they were obviously related to how to perform a solution to a certain problem. In this phase, basically there was no clear solution emerging. The 'solutions' at this stage were inspirations or mood board that were used to visualise the overall style of the design.

The phase of **Development** started when the first sketch of a possible solution was shown. In this phase the information was relatively simple compared to the former phase. The units that appeared at this stage were normally in two formats, i.e. sketch, sketch + text. For the sketches, they were coded as 'solutions' and sketch + text were coded as 'problem + solution'. This was based on the analysis of the submissions, when there were texts, it was normally because the designer was trying to indicate the problem shown or solved by the specific sketch. The sketches were coded as 'solution' not because that there was no problem related to this specific solution, but rather that the designer didn't show the problem clearly. There could be sketches that were coded as 'problem + solution' when there were a serious of sketches focused on a specific problem

and was easily captured by the researcher. There could also be units that are only 'texts', they could be coded as 'problem', 'problem + solution' dependent on the specific content.

The phase of **Communication** in this study was closely related to the presentation board, because this was the only communication stage that was clearly shown in the collected data. In the practice of the design industry, there could be several rounds of communication after solutions were produced either within the design team or with the clients. In this study, there was only one stage of communication and the material in this phase was also relative simple, most of them were only the four presentation boards, some have had extra pages showing the final designs or picture models. If the unit in this phase was only about the final design, it would be coded as 'solution'. If it also showed other contents such as the simulation of product use context, the material and manufacture, etc., it would be coded as 'problem + solution'.

6.3.3.3 Coding and reliability test

The coding was done using Nvivo 10. Figure 6.10 shows an example of the completed coding sheet. The coding was applied to each unit. When facing a unit, first of all, the researcher judged the phase it belonged to, then it was coded to one of the child codes, i.e. the 'problem', 'solution' or 'problem + solution'. When it was difficult to judge, it would be coded as 'undefined', which rarely happened during the whole process.

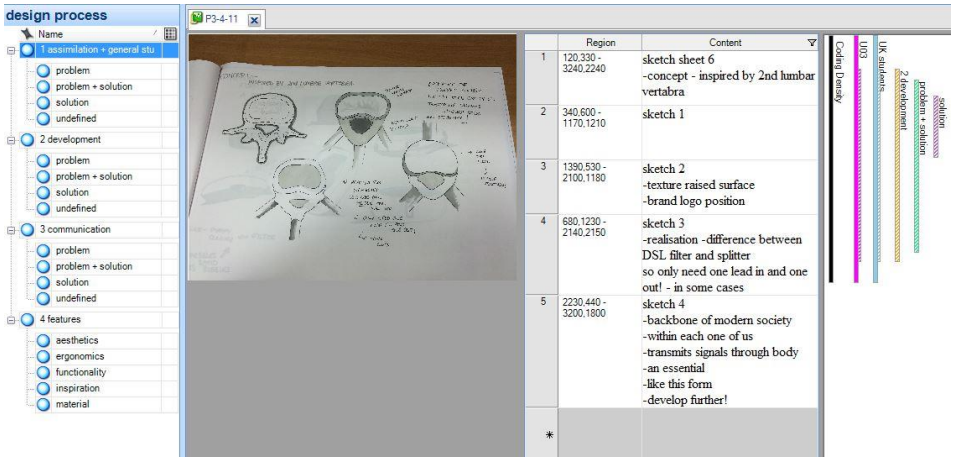


Figure 6.10 Example of a completed coding sheet

The coding was done by the researcher independently and also tested by a collaborator from the Human Factors Research Group who had a background of architecture design. There were in total 46 design submissions, the reliability test was applied to 10% of the overall data, i.e. 5 design submissions which were selected randomly from all the projects by the collaborator. To ensure the randomness of the reliability text, the projects were selected by the collaborator from some folded sheets with the project number, group number and participant number respectively (Figure 6.11). The five selected projects were Project 1 from UK participants No.1 and 7, Project 4 from Chinese participant No.2, '2+2' participant No.1 and UK participant No.6. The collaborator was introduced to the detailed criteria of each code and then completed the coding of the five design submissions independently.



Figure 6.11 The process of randomly selecting the project numbers

The Kappa coefficient of the comparison of the coding of each select project from the researcher and the collaborator was done using the 'Query' of 'coding comparison' from NVivo 10. The results were shown in Table 6.5. The average Kappa coefficient was 0.89 (SD: 0.09), which showed an excellent agreement between the coding of the researcher and the collaborator.

Table 6.5 Kappa Coefficient of each compared design report

Project No.	Kappa coefficient
P1 -- UK -- 1	0.96
P1 -- UK -- 7	0.89
P4 -- CN -- 2	0.75
P4 -- '2+2' -- 1	0.98
P4 -- UK -- 6	0.86

6.3.4 Semantic word cloud analysis on the design process

One aim of the study was to explore the patterns the two groups of participants used in formulating each design project and addressing the design attributes in the aspects of aesthetics, ergonomics, creativity etc. that were investigated in the previous study. Thematic analysis is one of the traditional ways of conducting similar qualitative research as it is flexible but also very useful (Braun & Clarke 2006). However, its flexibility is achieved at the cost of a relatively high level of subjectivity. In order to interpret the differences shown in the design submission in a more objective manner, the method used here was semantic word cloud analysis. Instead of identifying the themes subjectively by the investigator in a thematic analysis, the method of word cloud analysis uses the frequencies of the different words in the text to quantify the main themes (McNaught & Lam 2010). All the text from the design submissions written by the participants was transcribed into text in the content column in Nvivo, which mainly include two parts: the research that they conducted before and during the development of design ideas, and the supporting text generated alongside the sketches. Therefore this analysis was mainly focused on the text parts in the submissions. The application of word cloud analysis on text has become increasingly popular in recent years as a tool for abstracting, visualizing and comparing data (Heimerl et al. 2014; McNaught & Lam 2010; Stasko et al. 2008). However, some researchers also pointed out the shortcomings of using simple world cloud for text analysis, as it only uses the word frequency as the main reference index, without exploring the semantic relationships among the high frequency words (Wang et al. 2014; Barth et al. 2014). Researchers have also developed software that combines the interpretation of word frequency and semantic relationship between key words in order to explore the text at a deeper level. There are different ways to determine the semantic relationship between words. Barth et al. (2014) compared six algorithms for generating word clouds and developed an online system that implements all the algorithms (http://wordcloud.cs.arizona.edu).

The present study used this online system as the tool of generating the semantic word clouds. It used the word frequency as the index of ranking and the Cosine

Coefficient, which uses the co-occurrence of words with other words as the main index of similarity. The text used for this analysis was the transcription of the design submissions produced by Nvivo 10 and exported as 'log'. Words of 'sketch', 'sheet', 'board', 'presentation' (in Project 4) and 'picture' applied by the researcher to label relevant content in the submissions were removed as 'stop words' to avoid bias. Because the CN group used different design projects to the two other groups, their submissions were not used in this part of the analysis. The word clouds were generated from each project of the '2+2' and UK group, and from a 100 of the most frequently used words. Figure 6.12 shows the setting of the interface from the online system and the output from the text of the UK group in Project 1. The size of the words represent the ranking of the word frequency and the semantically related words were assigned the same colour.

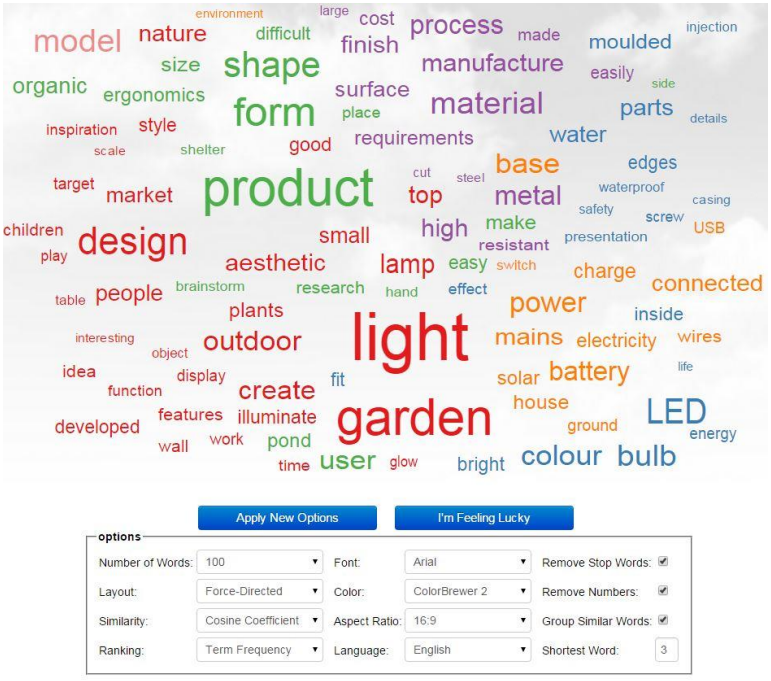


Figure 6.12 The setting of the interface

6.4 Results

6.4.1 Results of the observation study -- Context description

The results of the observation presented here were phenomenon concluded from the records taken from the studio. It was similar to a diary which describes the things seen and heard from the studio.

Two 'distinctive' groups

A common scenario that happened in the design studio was that, when the students were gathered, the six '2+2' students picked the seats together side by side in one corner and all the other UK students took up the rest of the space in the studio. This did not necessarily mean that the two groups did not want to have contact with each other. Actually the UK students were quite interested or maybe curious about their newly joined Chinese colleagues. As Participant No.6 (UK) talked about their Chinese classmates, "I think they are quite shy, don't talk much… I'm really interested in their drawings… I like the elements they used like the bamboo, the Chinese style garden… " On the other side, the '2+2' students were also quite eager to make contact with the native students. Some may be driven by the feeling of uncertainty, which had been with them since they stepped into this country, and were eager to find out how things worked here. Participant No.1 ('2+2') always tried to walk around the studio to see what the other students were actually doing. But her observing behaviour did not normally last long. She said it was kind of weird to stand behind others but have nothing to say so she quickly gave it up. This scenario lasted from the beginning of the course, in the main design studio, until the end of this study.

The most important reason for such a situation in the studio could be attributed to the language barrier, and the psychological barrier caused by the language barrier. As Participant No.5 ('2+2') described the feeling when she tried to discuss some design issues with a UK colleague, "I found that I can only describe very simple concepts although what I really mean was much more sophisticated. It felt like a school pupil trying to talk to a college student… feels really stupid and helpless." They had been studying in an all-English environment in Ningbo campus for two years before they came here, and were supposed be competent in using English. However, it turned out that using conversational English in an English speaking class in China with all Chinese classmates and in a class that was full of native UK speakers was totally different. They seemed to lose their confidence all of a sudden. Participants No. 1 and No.4 ('2+2') even commented

that they had difficulties in understanding the lectures. This kind of obstacle greatly limited the communication between the two groups.

'Cultural shock'

When creating the mood board for Project 2, Participant No.2 ('2+2') picked the brand of Ferrero Rocher as her source of inspiration. She described Ferrero Rocher as "elegant, romantic, high-end", which was the common brand impression from most of the Chinese consumers. However, just as one of the tutors pointed out, this was quite funny because UK people seemed to have quite a different feeling toward that brand. The truth was that, a TV advertisement of Ferrero Rocher called *The Ambassador's Party* with a funny and ridiculous style was widely spread to a generation of the UK population and it set the tone for the main impression of that brand to the majority of UK people.

The strong contrast between the two different understandings revealed partly the cultural shock to the '2+2' students in this particular environment. Actually it did not only occur in the small design elements that were used in the design process, sometimes the design project as a whole could leave the '2+2' students at a total loss. Take the project of Garden Lighting for instance; gardens are very common for UK people, for many people in the UK live in houses. However, for most Chinese people, they do not have the same concept of garden as their UK counterparts, especially for the six '2+2' students who came from cities. Most of them lived in high-rise flats and for them gardens were more of a means of communal facilities rather than private property. Therefore it was not a surprise that Participant No.3 ('2+2') started with, and spent a great deal of his time of this project, in researching garden types. The same situation also happened in Project 2, which was about designing bicycle accessories. Apparently buying and riding a bicycle in China and in the UK are quite different experiences. In the UK, there is a strict highway code for cyclists; one needs to equip the bicycle properly with front & rear lights and reflectors, wear appropriate clothes and know well all the traffic rules before they use the road. Whilst in China, buying a bicycle is much simpler, which usually means only paying the bill for the bicycle. Therefore,

for the '2+2' students to finish this project, they really needed to figure out at first, what bicycle accessories meant.

'Differences' Vs. 'Interaction'

In the Garden lighting project, Participant No.3 ('2+2') mentioned above who started with researching garden types actually spent more than half of his time in sketching the different garden types. His point was that when he was sketching the gardens, he was also thinking about the possible lighting solution. When closely observing the students doing their design work, it was not difficult to find that compared to '2+2' students, the UK students tend to produce many more sketches and they also tended to draw more quickly. If the time sketching in the studio was calculated, the number would be quite different between the two groups. Take Participant No. 9 (UK) as an example, according to the observation, the hours he spent in the studio was mostly for sketching. The speed of his sketching was quite fast. He tended to draw lots of sketches with hardly any break in between. When being asked if he had got a clear idea before he started every sketch, he said: "No, actually not. I just start drawing and add anything from the mood board that inspired me. Like this texture, or the shape of this figure… " While for the '2+2' students, instead of sketching, they spent much more time in thinking about the problems. Participant No.1 ('2+2' group) said that she tended to think through the problem first, and then she would present the things that had already been thoroughly thought through in her mind as sketches. She said it was probably because she was not so confident in sketching and she didn't think she can sketch well unless she had already got a very clear idea in her mind.

Actually, the '2+2' students were also aware of this type of difference between them and their native classmates. After they got the results of the first design task from their tutors, Participant No.3 ('2+2' group) seemed to be quite disappointed. He said: "They (British students and tutor) are just different from us, and their judging criteria are more suitable for their ways of presenting designs… It's difficult for us to get a high mark …" This was only partly right: first

of all, a few of the '2+2' students actually got quite high marks; secondly, as time went by, the interaction between the two groups seemed to increase to some extent and it influenced the way of designing of the '2+2' students. As they became more comfortable with each other, the communication became more natural between the two groups. Even the two distinct zones in the studio at the beginning became less rigid. At a later stage of this study some of the '2+2' students moved to small rooms with other UK students. Compared to the UK students, the '2+2' students were more aware of learning from their UK colleagues. One common phenomenon which usually happened on the day when the mark sheets were issued was that, the '2+2' students would search for the high mark submissions to see how they were different from their own and they tried to learn from them. Due to all these increasing interactions, there seemed to be some obvious change in the '2+2' design activities. One significant difference was that they tended to intentionally produce more sketches in their submissions, especially in the later projects.

The presence of the '2+2' students also influenced the UK group to some extent. One of the examples was that, some of the UK students tended to take elements from the Chinese culture as a source of inspiration. Quite a lot of Chinese images appeared in their sketches, for example, Participant No. 8 in her Project 1 sketched Chinese style bridges, potted plant, lantern, furnace, etc. and taking the lantern as a main source for developing her ideas; Participant No. 8 took a Chinese garden as a type garden in her research; Participant No. 5 took the "Yin and Yang eight diagrams"'2+2' as inspiration.

6.4.2 Results of coding analyses on the design process

The number of units under the codes of problem, problem + solution and solution in each phase (A+G = Assimilation + general study, D = Development, C = Communication) of Project 1 and Project 4 produced in NVivo 10 were calculated and the mean values are listed Table 6.6. Figure 6.13 – 6.14 show the mean numbers of coding units in each phase.

Table 6.6 Mean numbers of coding units of Project 1 and Project 4

		Project 1			Project 4		
		'2+2'	**CN**	**UK**	**'2+2'**	**CN**	**UK**
A+G	P	17.83	27.33	26.27	11.5	37.5	15.73
	P+S	7.67	27	24.55	33.33	19.5	13.36
	S	3.17	0.17	35.45	7.5	25.33	45.73
	Total	28.67	54.5	86.27	52.33	82.33	74.82
D	P	0.83	0.17	0.27	0	0	0.09
	P+S	22.83	32	42.55	23.33	11	29.18
	S	45.17	37.83	72.18	57.67	39	61.45
	Total	68.83	70	115	81	50	90.72
C	P+S	6.83	0	5.27	3.17	5	3.27
	S	1	1.33	2.82	1.33	2.67	1.36
	Total	7.83	1.33	8.09	4.5	7.67	4.63

Note. P = problem, P+S = problem + solution, S = solution, similarly hereinafter

6.4.2.1 Statistical analyses of the differences in coding results

Statistical analyses were performed to examine the differences in the numbers of coding units of each group:

Phase 1: Assimilation + general study

Project 1: A one-way multivariate analysis of variance was performed to determine the effect of groups on the numbers of coding units of 'problem', 'problem + solution' and 'solution'. Outliers were found in the test, which were the data in 'solution' from Participant No. 2 ('2+2') (14), No.6 (CN) (1) and in 'problem + solution' No.3 (UK) (66). They were replaced with a number that is 1 more than the next most extreme value respectively (14→4, 1→0 and 66→36)[7]. Preliminary assumption checking revealed that the data from 'solution' of the UK group ($p = 0.38$) was not normally distributed, as assessed using the Shaprio-Wilk test. However, the test was run regardless given that the one-way MANOVA is fairly robust to deviations from normality. There were no univariate or multivariate outliers, as assessed by boxplot and Mahalanobis distance ($p > .001$), respectively; there were approximately linear relationships, as assessed by scatterplot; no multicollinearity, 'problem' & 'problem + solution' ($r = -.003$, p

[7] For example, in '2+2' group, the next most extreme value in solution was 3, therefore 14 was replaced with 4 (3+1).

= .990), ‘problem + solution’ & ‘solution’ (r = -.262, p = .228), ‘problem’ & ‘solution’ (r = .357, p = .094); and there was homogeneity of variance-covariance matrices, as assessed by Box's M test (p = .002). The differences between the groups in the coding units mean numbers were statistically significant, F (6, 36) = 5.516, p < .001; Wilks' Λ = .271; partial η^2 = .479. Tukey post-hoc tests showed that for ‘problem + solution’, coding unit mean number from ‘2+2’ group was statistically significantly lower than coding unit mean number from either CN (p = .002) or UK group (p = .009). Also for ‘solution’, coding unit mean number from the UK group was statistically significantly higher mean scores than coding unit mean number from either CN (p = .029) or ‘2+2’ group (p = .037).

Project 2: The same test was run to determine the effect of groups on the numbers of coding units of ‘problem’, ‘problem + solution’ and ‘solution’. Outliers were found in the test, which were the data from Participant No. 2 (‘2+2’) in ‘problem’ (35) and ‘solution’ (45). They were replaced with a number that is 1 more than the next most extreme value respectively (35→13, 45→0). Preliminary assumption checking revealed that the data from ‘problem’ of the UK group (p = 0.34) was not normally distributed, as assessed Shaprio-Wilk test. The test was run regardless given that the one-way MANOVA is fairly robust to deviations from normality. There were no univariate or multivariate outliers, as assessed by boxplot and Mahalanobis distance (p > .001), respectively; there were approximately linear relationships, as assessed by scatterplot; no multicollinearity, ‘problem’ & ‘problem + solution’ (r = -.062, p = .778),’ problem + solution’ & ‘solution’ (r = -.152, p = .489), ‘problem’ & ‘solution’ (r = .283, p = .191); and there was homogeneity of variance-covariance matrices, as assessed by Box's M test (p = .048). The differences between the groups on the coding units mean numbers were statistically significant, F (6, 36) = 5.567, p < .001; Wilks' Λ = .269; partial η^2 = .481. Tukey post-hoc tests showed that for ‘problem’, coding unit mean number from CN group was statistically significantly higher than coding unit mean number from either ‘2+2’(p = .003) or UK group (p = 0.012). Also for ‘solution’, coding unit mean number from the UK group was

statistically significantly higher mean scores than coding unit mean number from '2+2' group (p = .010).

From the graph shown in Figure 6.13 - 6.14, some tendencies could be found among the three groups. The '2+2' group tended to show little material in the 'problem + solution' and 'solution' codes in Project 1, whereas in Project 4, the situation changed a lot, especially in the codes of 'problem + solution' and 'solution'. The same situation also happened to the CN group in the code of 'solution'. One outstanding result in this phase is that the UK group, compared to the other two Chinese groups, tended to more codes in solution.

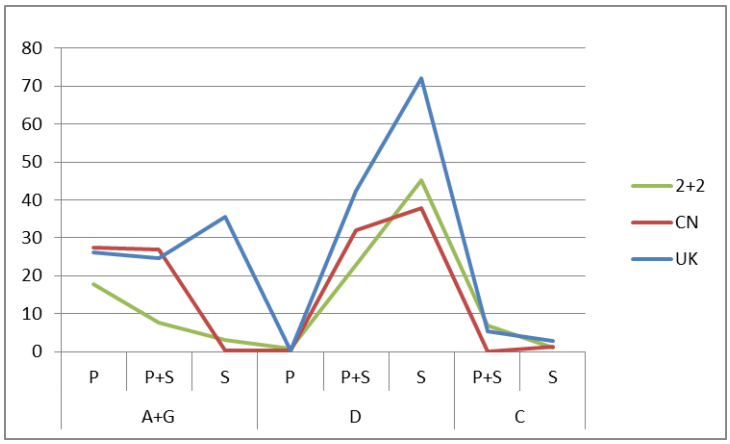


Figure 6.13 Mean numbers of coding units in each phase in Project 1

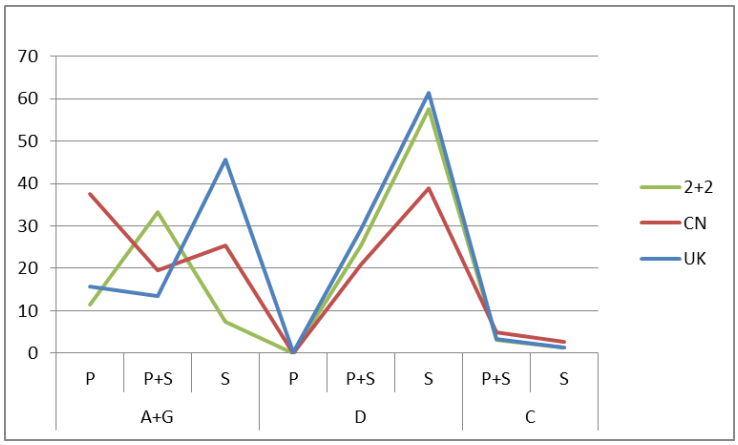


Figure 6.14 Mean numbers of coding units in each phase in Project 4

Phase 2: Development

Project 1: Because the data shows that there were few 'problem' coding units at this phase for all the three groups, the relevant data was excluded for statistical

testing. A one-way multivariate analysis of variance was run to determine the effect of groups on the numbers of coding units. Outliers were found in the data of Participant No. 2 ('2+2') in 'problem + solution' (54) and No. 3 ('2+2') in 'solution' (124). They were replaced with a number that is 1 more than the next most extreme value (54→29 and 124→43 respectively). Preliminary assumption checking revealed that all the data was normally distributed (p >.05), as assessed Shaprio-Wilk test. There were no univariate or multivariate outliers, as assessed by boxplot and Mahalanobis distance (p > .001), respectively; no clear linear relationships for the data from the UK group were found, but the analysis was run given this; no multicollinearity (r = .420, p = .046); and there was homogeneity of variance-covariance matrices, as assessed by Box's M test (p = .002). There were no significant differences in the mean numbers of coding unit between the groups, F (4, 38) = 2.085, p = .101; Wilks' Λ = .664; partial η^2 = .185. Follow-up univariate ANOVAs showed that the numbers of coding units of 'problem + solution' (F (2, 20) = 3.777, p = .041; partial η^2 = .274) was statistically significantly different between the three groups. Tukey post-hoc tests showed that for the 'problem + solution', coding unit mean number from the '2+2' group was statistically significantly lower than the coding unit mean number from the UK group (p = .033).

Project 2: The same test was run to determine the effect of groups on the numbers of coding units of 'problem + solution' and 'solution'. Outliers were found in the data of 'problem + solution' in Participant No. 6 (CN) (33) and No. 5 (UK) (107). They were replaced with a number that is 1 more than the next most extreme value (33→12 and 107→49 respectively). Preliminary assumption checking revealed that all the data were normally distributed (p >.05), as assessed Shaprio-Wilk test. There were no univariate or multivariate outliers, as assessed by boxplot and Mahalanobis distance (p > .001), respectively; no clear linear relationships for some of the data, but the analysis was run given this; no multicollinearity (r = .108, p = .623); and there was homogeneity of variance-covariance matrices, as assessed by Box's M test (p = .007). The differences between the groups on the coding units mean numbers were not statistically

significant, F (4, 38) = 2.085, p = .093; Wilks' Λ = .665; partial η^2 = .185. Follow-up univariate ANOVAs showed that the numbers of coding units of problem + solution (F (2, 20) = 3.856, p = .038; partial η^2 = .278) was statistically significantly different between the three groups. Tukey post-hoc tests showed that for 'problem + solution', coding unit mean number from the CN group was statistically significantly lower than coding unit mean number from the UK group (p = .041).

An interesting change took place in the three groups. In Project 1, the coding in 'problem + solution' and 'solution' for the '2+2' and CN groups were quite close, but in strong contrast with the UK group. When it comes to Project 4, the same codes from the '2+2' were highly close to the 'UK' group instead of the 'CN' group.

The results of the statistical test are summarised in Table 6.7.

Table 6.7 Summary of the statistical test on the number of coding

Phase	Subject	Result	Statistical test result	
Phase 1	Project 1	1. There were significant differences in the mean numbers of coding unit.	One-way MANOVA	F (6, 36) = 5.516, p < .001; Wilks' Λ = .271; partial η^2 = .479
		2. For 'problem + solution', '2+2' was significantly lower than CN or UK.		'2+2' vs. CN: p = .002; '2+2' vs. UK: p = .009
		3. For 'solution', UK was significantly higher than '2+2' and CN.		UK vs. CN: p = .029; UK vs. '2+2': p = .037
	Project 2	1. There were significant differences in the mean numbers of coding unit.	One-way MANOVA	F (6, 36) = 5.567, p < .001; Wilks' Λ = .269; partial η2 = .481
		2. For 'problem', CN was significantly higher than '2+2' or UK.		CN vs. '2+2': p = .003; CN vs. UK: p = .012
		3. For 'solution', UK was significantly higher than '2+2' and CN.		UK vs. '2+2': p = .010
Phase 2	Project 1	1. There was no significant difference in the mean numbers of coding unit.	One-way MANOVA	F (4, 38) = 2.085, p = .101; Wilks' Λ = .664; partial η2 = .185
		2. There were significant differences in the mean numbers of coding unit of 'problem + solution'.		F (2, 20) = 3.777, p = .041; partial η2 = .274
		3. For 'problem + solution', '2+2' was significantly lower than UK.		'2+2' vs. UK: p = .033
	Project 2	1. There was no significant difference in the mean numbers of coding unit.	One-way MANOVA	F (4, 38) = 2.085, p = .093; Wilks' Λ = .665; partial η2 = .185
		2. There were significant differences in the mean numbers of coding unit of 'problem + solution'.		F (2, 20) = 3.856, p = .038; partial η2 = .278
		3. For 'problem + solution', CN was significantly lower than UK.		CN vs. UK: p = .041

6.4.2.2 Visualisation of the differences

The analyses above were drawn from the numbers of codes in each phase of the design process in a quantitative way. Actually the codes of 'problem', 'problem + solution' and 'solution' were not essentially equal to each other. They presented the different cognitive units that occur in the design process from the problems to the solutions. In order to reveal the connotations that were carried by the codes, the data was visualised in the research model in a way shown as follows:

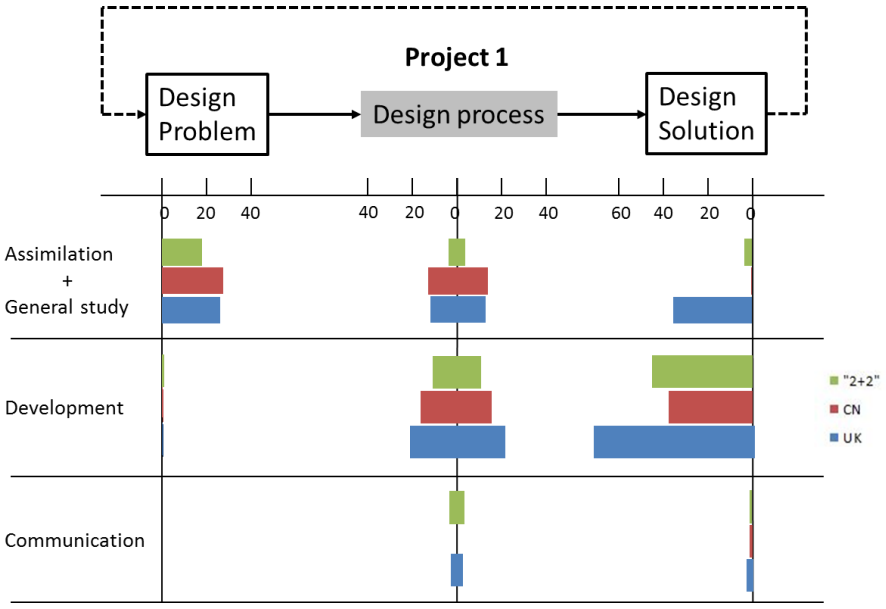


Figure 6.15 Visualization of the design process of the three groups in Project 1

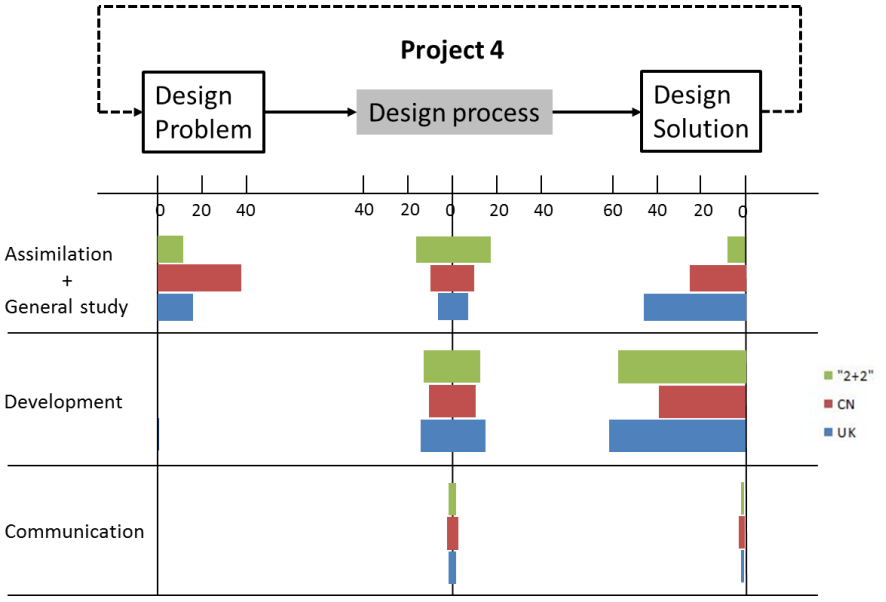


Figure 6.16 Visualization of the design process of the three groups in Project 1

From the graphs in Figure 6.15 and 6.16, it can be seen that the UK group were more solution-orientated at the stage of **Assimilation + general study**. This difference was very obvious at the beginning of their design practice, which was shown in Project 1. When it came to Project 4, as the two Chinese groups tended to focus more on the solutions at that stage, the difference became smaller, but was still quite significant. The UK group also produced far more solutions compared to their Chinese counterparts at the stage of **Development**, especially in Project 1. The CN group showed similar performance in the sense of solution numbers at this stage in the two projects, while the '2+2' group had a compelling change in this from Project 1 to Project 4.

6.4.3 Results of semantic word cloud analysis on the design process

6.4.3.1 Project 1 – Garden lighting

Figure 6.17 and 6.18 are the word clouds of Project 1 from '2+2' and UK group. The two word clouds suggest some differences in the way of constructing the design process of the 'garden lighting' from the two groups. The '2+2' group's word cloud contains five main themes according the five different colours, which were 'light', 'material', 'shape', 'design' and 'part'. The UK group also got five main themes, which were 'light', 'product', 'LED', 'material' and 'power'.

The two groups shared the same main themes of 'light' and 'material' but had differences in the detailed interpretation and exploration. For the 'light' theme, which was the main design object of the Project, the '2+2' group explored it a lot together with the 'image' of gardens. They did a lot of research on the 'gardens' and took it as a main source of inspiration.

For the UK group, their research focused more on 'garden light' as a whole concept, they considered the 'outdoor' environment as an environment for using the design and investigated aspects of 'aesthetics', 'lamp' type, 'people', etc. under this theme. Compared to their Chinese counterparts, the UK groups also showed strong awareness of the task as a concept of 'design', as they used the word 'design' 86 times compared to the 10 times from the '2+2' group. 'Material' is one of the key themes for both groups. For the '2+2' group, material

basically related to two aspects—the material of the 'bulb' and the material of the light base. The latter one was the one they focused on more, for which they considered the 'surface', 'frame' and 'finish'. For the UK group, their concerns with material were more related to the manufacturing aspect, which they concerned themselves about the 'finish', 'surface', 'cost' and 'requirements'. As LED is one of the most popular light sources, both groups took it as the main light source in their designs.

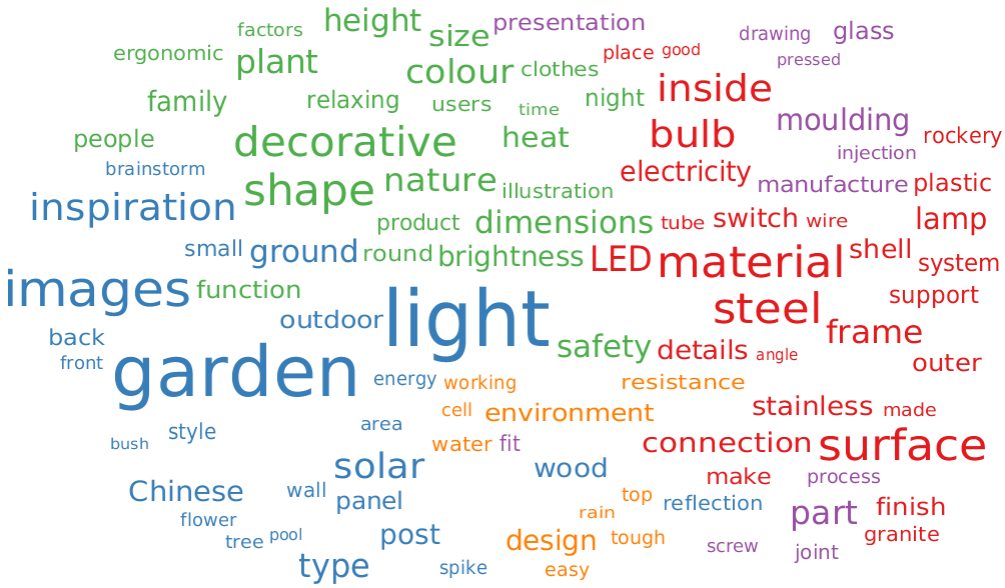


Figure 6.17 100 words semantic word cloud of the '2+2' group in Project 1

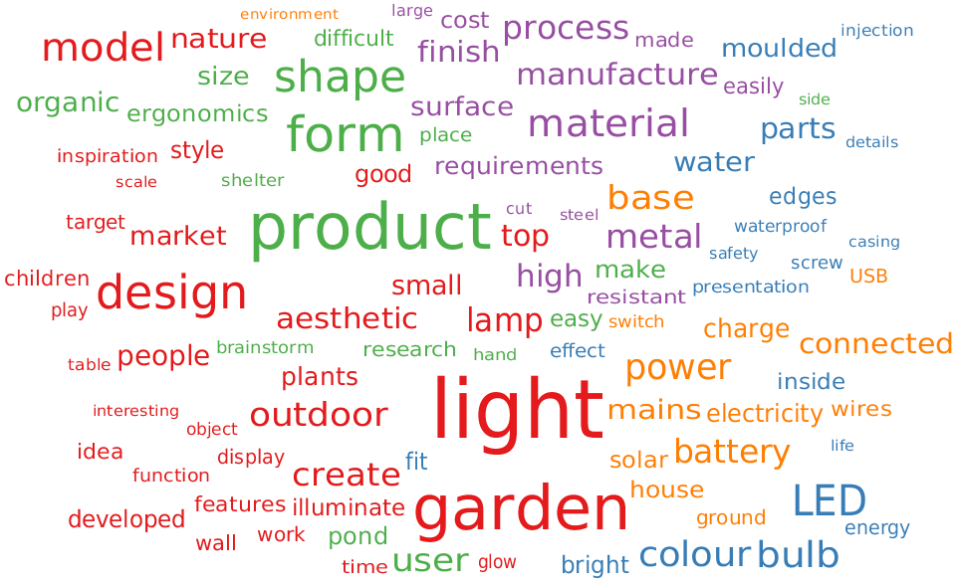


Figure 6.18 100 word semantic word cloud of the UK group in Project 1

The '2+2' group had a theme of 'shape', which mainly dealt with the aspects of design aesthetics and ergonomics. For the aesthetics aspect, they were concerned with the 'decorative' values, the 'colour' and 'size' and they valued a lot of elements from 'nature' such as 'plants' in their designs. For the ergonomics, they mentioned the 'size', 'height' and 'dimensions', and also 'safety', 'brightness' and 'function'. The corresponding theme from the UK group was the 'product', for which they referred to the aesthetics aspect such as 'shape' and 'form', they also highly valued 'organic' elements; also aspects of ergonomics, such as 'size', and focused a lot on 'users'. They had an intention to make the design easy for 'users', which was not mentioned by the '2+2' group.

Compared to the UK group who related the 'material' closely with the 'manufacture process', the '2+2' group tended to deal with the manufacture process independently in the 'moulding' theme. They dealt with the 'moulding process', the 'parts' and 'joints', etc. The UK group had a similar theme of 'LED', for which they focused a lot on the 'bulb', for its 'colour', 'brightness' and 'energy' consumption. They also emphasise 'safety' in this theme. With the possible environmental consideration of water (from precipitation), they claimed the design to be waterproof. For the '2+2' group, they had an independent theme of design which focused on the 'working environment' of the design. They also claimed the product to be 'water resistant'.

6.4.3.2 Project 4 – Broadband filter

Figure 6.19 and 6.20 are the word clouds of Project 4 from the '2+2' and the UK group. Compared to the word clouds of Project 1, the two clouds from Project 4 were more complicated. This could be attributed to two reasons: firstly, the project itself was more complicated and the requirements for the design report were much higher than Project 1. For example, they were asked to consider the inside of the product and to detail the way the unit is constructed and fits together; they were also required to use product semantics to define the product form, etc. The other reason was that after about six months' practice in design and having finished three design projects, the students were more experienced in

designing and more advanced in design skills, therefore they were able to think in a more sophisticated way when designing.

The two word clouds suggest some differences in the way of constructing the design process of the 'broadband filter' from the two groups. The '2+2' group's word cloud contains six main themes, which were 'filter', 'design', 'moulding', 'part', 'fit' and 'information'. The UK group also used six main themes, which were 'product', 'filter', 'mould', 'form', 'handle' and 'wall'.

The two groups shared the same main themes of 'filter' and 'mould'/ 'moulding'. They perceived the theme of 'filter' in a quite similar way, for which they researched in detail of how a broadband filter works: how does it 'connect' with / 'split' 'broadband' / '(A)DSL' and 'telephone' / 'phone' 'line' 'signals'. A small difference was that the '2+2' group emphasised the concept of 'socket' and 'plug', while the UK group interpreted this in an independent theme together with 'wall thickness'. A corresponding theme from the '2+2' group is the 'fit' theme, in which they connected the 'wall thickness' with 'snap - fit' and 'snap arms'. For the 'mould'/ 'moulding' theme, both the two groups related it to 'material'. The differences were: the UK group talked about the 'snap - fit' here rather than together with the 'wall thickness' as the '2+2' group had done, they also talked about other detailed manufacturing features such as 'edges', 'casting', 'angle', 'pins', etc. The '2+2' group mentioned the aspects of aesthetics such as 'shape', 'colour' and 'modern' under this theme and echoed with their performance in Project 1. Once again they took the 'images' of 'home', which was the use environment of the product, as a main source of inspiration. The UK group had an independent theme of 'form' which was closely related to the 'semantics' that was required in the brief. They addressed the 'shape', 'colour' and 'concept' 'development' together with the 'semantics', which could be taken as a source of inspiration. The '2+2' group had another distinguishable theme for 'manufacture', which was the 'design' and this was closely related to the concept of 'assembly'. Compared to the '2+2' group's performance in Project 1, the word 'design' appeared 83 times in Project 4, which was very close to the number of 93 of the UK group. A great proportion of the use of the word 'design' appeared

together with 'assembly' and indicated that the '2+2' had gained more awareness of the concept of 'design' as time went by (see Figure 6.21 for example). On the other hand, the 'design' from the UK group appeared in the theme of 'Product' and they were mostly expressed as the design activity itself (see Figure 6.22 for examples).

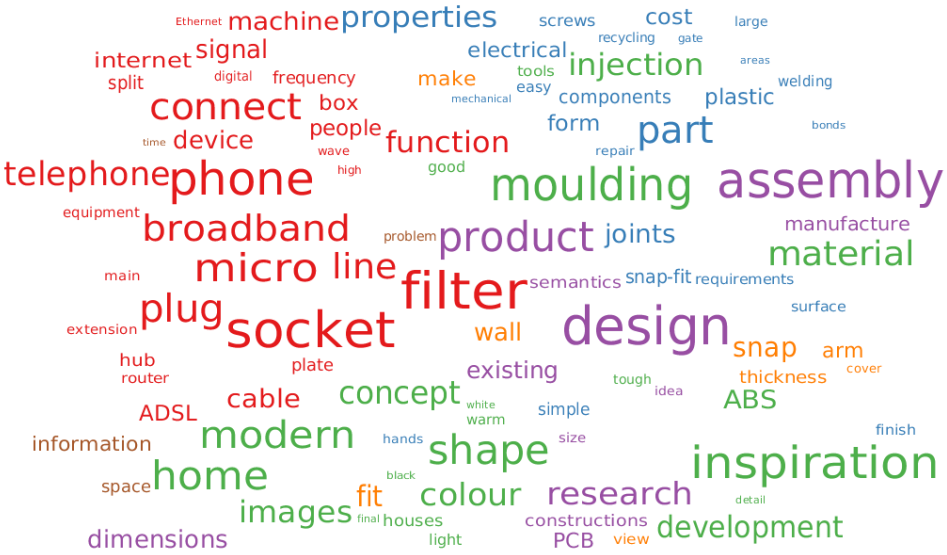


Figure 6.19 100 words semantic word cloud of the '2+2' group in Project 4

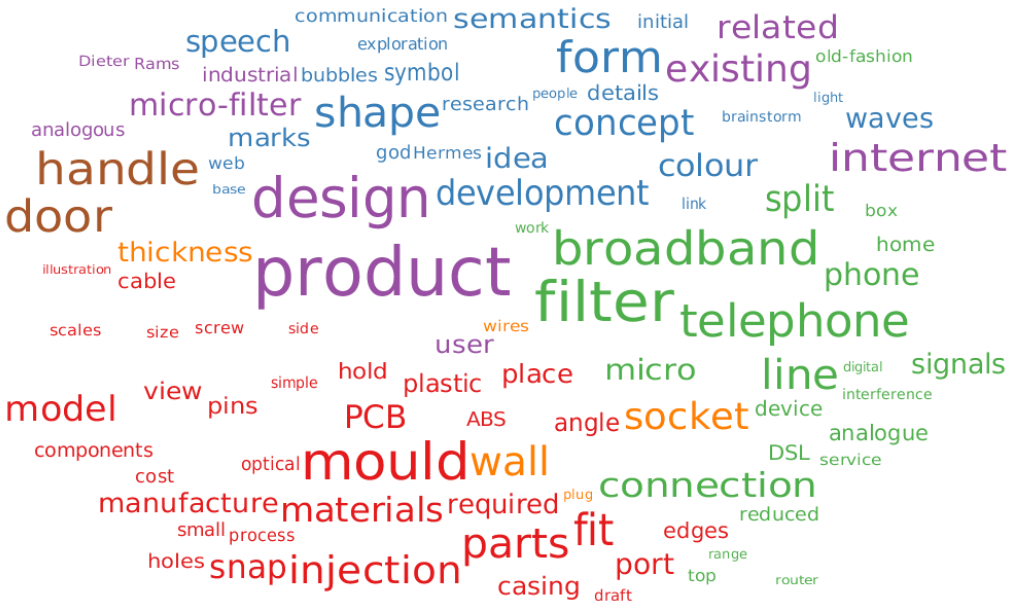


Figure 6.20 100 word semantic word cloud of the UK group in Project 4

<Internals\\Study 3\\UK\\Project 4\\C3\\C3-4-16> - § 2 references coded [75.03% Coverage]

Reference 1 - 75.03% Coverage

design for assembly 4

Reference 2 - 10.48% Coverage

design for

<Internals\\Study 3\\UK\\Project 4\\C3\\C3-4-17> - § 3 references coded [71.42% Coverage]

Reference 1 - 71.42% Coverage

design for assembly 5

Reference 2 - 0.91% Coverage

design simple straight-draw, snap-fit

Reference 3 - 0.94% Coverage

annular **designs**

<Internals\\Study 3\\UK\\Project 4\\C3\\C3-4-18> - § 1 reference coded [67.00% Coverage]

Reference 1 - 67.00% Coverage

design for assembly 6

Figure 6.21 Examples of the word 'design' in the transcription of design submissions from the '2+2' group

<Internals\\Study 3\\UK\\Project 4\\P2\\P2-4-18> - § 1 reference coded [13.06% Coverage]

Reference 1 - 13.06% Coverage

model used to help aid **design** and *. also used to product

<Internals\\Study 3\\UK\\Project 4\\P2\\P2-4-19> - § 1 reference coded [8.90% Coverage]

Reference 1 - 8.90% Coverage

sketch 2
-size and dimensions
-**design** is significant and * in its

<Internals\\Study 3\\UK\\Project 4\\P3\\P3-4-01> - § 1 reference coded [11.18% Coverage]

Reference 1 - 11.18% Coverage

design a domectis use DSL/Microfilter

<Internals\\Study 3\\UK\\Project 4\\P3\\P3-4-02> - § 5 references coded [84.47% Coverage]

Reference 1 - 84.47% Coverage

design specific requirements:

Reference 2 - 11.43% Coverage

-simplicity - my **design** must be simple in design

Figure 6.22 Examples of the word 'design' in the transcription of design submissions from the UK group

6.5 Discussion

The present study aimed to investigate the differences shown in the design processes between the UK and Chinese design students. The sample of Chinese design students consisted of two parts, i.e. the '2+2' group that were from China but studying in the UK when the study took place and the 'CN' group that had all their education in the Ningbo China campus. Having the 'CN' group as the control group, allowed the researcher to distinguish the differences from the perspective of cultural influences and the differences as a result of other effects such as the educational environment (this will be discussed later in this section).

The differences were found in both Phase 1 and 2 in the design process between the UK and Chinese students. The findings are concluded and presented in the research model as shown in Figure 6.23.

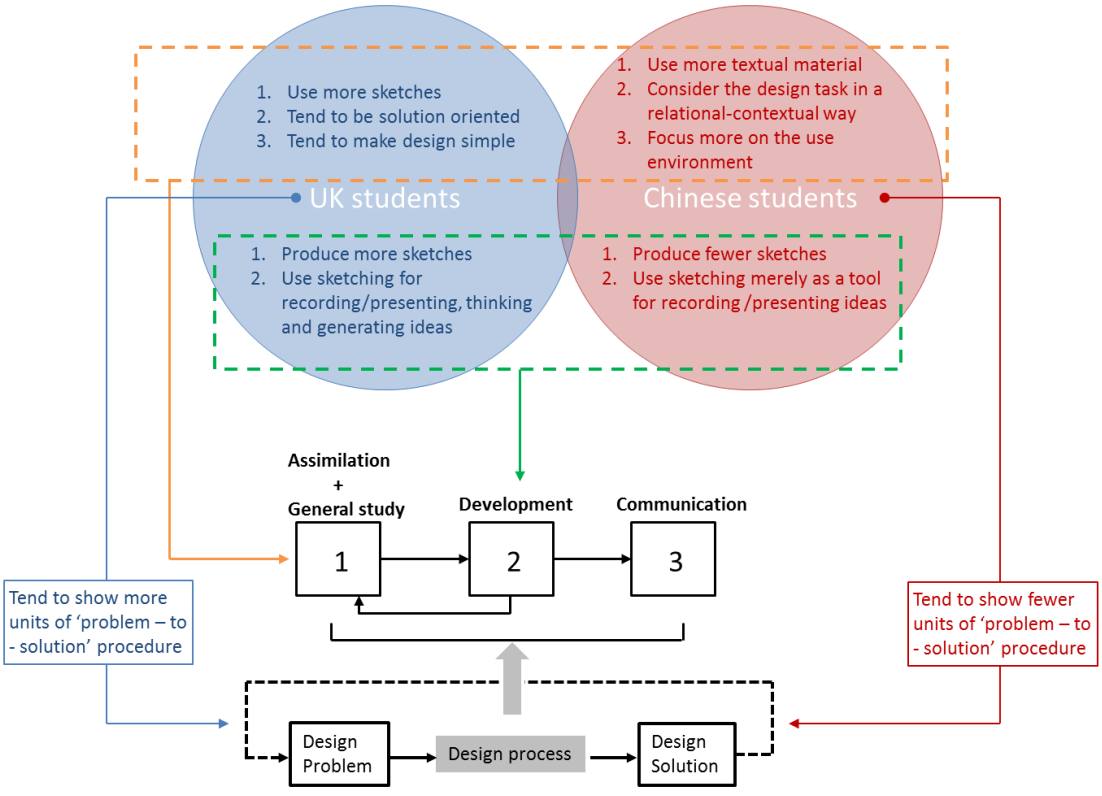


Figure 6.23 Differences found in design process between the UK and Chinese design students

6.5.1 The different ways of perceiving sketches

According to some researchers, the drawing employed by designers is not only for recording ideas, it also helps in generating them (Bilda et al. 2006; Menezes & Lawson 2006). However, according to the observation, there seems to be quite different ways between the '2+2' students and the UK students in their use of sketching. Compared to their Chinese counterparts, the UK students used sketches more as a technique for exploring possible solutions. Therefore they tended to draw more and faster. Their design solutions were being formulated during the process of drawing, which is in accordance with the results from the relevant studies (Bilda et al. 2006; Rodgers et al. 2000; Tovey et al. 2003). However, for the Chinese students, especially at the early stages of their design practice, they used sketches more as a tool of recording their design process after they had already finished the process of idea generation.

Part of the reasons for this type of difference could be due to their experience with drawing, which was revealed by some short interviews with the students. For the UK students, before they entered the design degree, most had taken some relevant courses in their A-level studies. Although this kind of pre-study was really brief, it gave them a basic idea that design is about using the sketches to communicate. Communication does not only refer to communicating with other people but also communicating with the design objects themselves, which echoes with Schön's (1991) famous description "the singer having a conversation with the drawing". It assists the designer in translating descriptive propositional information into depiction and also performing as a thinking and reasoning aid which is an essential part of the design activity. However, only one of the '2+2' Chinese participants in this study had some experience with drawing before starting the course. Therefore compared with their UK counterparts, they were lacking in confidence in sketching. For them, how to sketch itself was a problem which needed solving. Therefore they could not sketch as freely as they would have liked to.

At the later stage of this study, according to their submission, the '2+2' students tended to produce many more sketches. This was partly due to the improvement of their sketching skills and also the awareness gained from their comparison with other 'high marked' submissions that; more sketches would gain higher marks. This phenomenon could be well indicated by Hofstede's (2010) the dimension of **Long-Term Orientation.** In his list of key differences between short- and long-term orientation societies, he declared long-term orientation societies tend to learn from other countries. However, according to the observation, although the numbers of sketches increased considerably, the way they used the sketches did not change a lot. They still tended to have the features of the sketches prepared in their mind readily and then presented them in sketches, rather than thinking whilst sketching.

Hall's (1989) cultural dimension of high and low-context, to some extent, probably suggests some explanation for this kind of difference between the UK and Chinese students. According to Hall, in the high-context cultures, the outside environment is found to be much more important than the inside settings. High-context communication has been identified as being indirect, ambiguous, maintaining harmony, reserved, and understated (Gudykunst et al. 1996). The Chinese society is a typical example of high-context culture. Chinese people tended to express less than the conversation that actually took place in their mind, which when applied to design activities, the designers presented much less than the things that were in their mind. On the contrary, UK people are in a low-context system, in which the communications are largely dependent on the information to be direct/explicit, precise, dramatic, open, and are based on feelings or true intentions (Gudykunst et al. 1996). Therefore, the UK students tended to naturally present things that was going on in their mind. One thing that needs to be noted here is that, less information presented in the submissions does not necessarily means that the cognition process of design activities of the Chinese students was much simpler than the ones of the UK students. It may be highly likely that the Chinese students also have highly rich information that was

progressing in their minds but only chose to present part of this information. A further study could be conducted to explore this in greater detail.

6.5.2 The differences shown in the design process from the coding analysis

6.5.2.1 Differences in the Phase of Assimilation + general study

The data referring to the Phase 1 of the design process, from the three groups of participants, does not show obvious differences between the Chinese and the UK student designers. Actually, as Lawson (2006) pointed out, in this phase of the design process, the submissions contain a great deal of information that was slavishly gathered at the beginning of the project and the students are often unable to point to any material effect on their solutions for a large section of the collected data. For the participants of this study who were new to design practice, this kind of phenomenon was very obvious. They were not sure about what types of information to look for and what types of information should be presented in the submission. The results therefore usually turned out to be that they would put anything that they found into the submissions, no matter whether it had a relationship to the design solution or not. One of the common materials submitted by Chinese students at this stage was pages from books about manufacture and materials without any personal interpretation. They also tended to use more literal material (Figure 6.24). On the other hand, the UK students tended to present pages of pictures (Figure 6.25). With the experience accumulated, the Project 4 submissions tended to be more succinct.

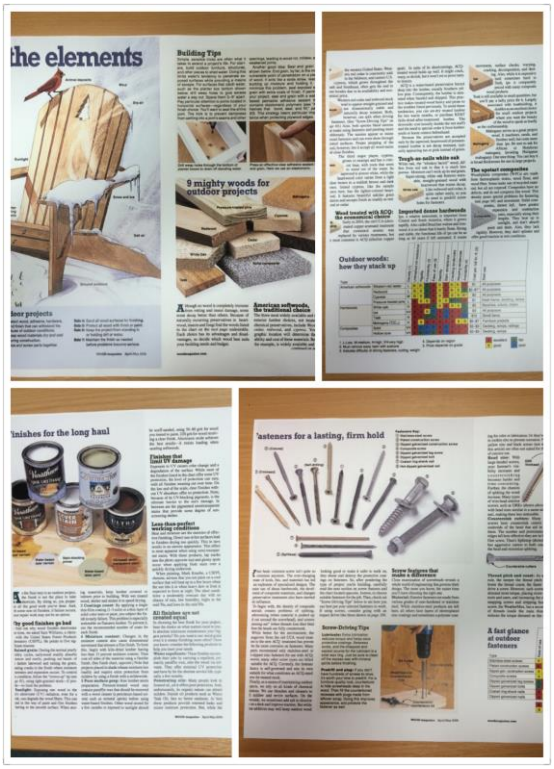


Figure 6.24 Example pages from the report of a '2+2' student



Figure 6.25 Example pages from the report of UK students

However, given all the unstructured information shown in the submissions, the solution-orientated tendency of the UK group was notable. Compared to their Chinese counterparts, in this phase the UK students tended to use many more mood boards and pictures for inspiration. The mood boards were frequently used as the inspiration for the shapes, styling or colour and always had a high correlation with the design. For example, in Figure 6.26, the lower left design was inspired greatly by the shape of the shells of the nuts from the mood board; the basic shape of the design on the lower right is taken from the element of spiral, shown in the mood board. The frequent use of the mood boards by the UK participants in this phase indicates the solution-orientated attributes.



Figure 6.26 Examples of mood board and final design from the UK participants

Furthermore, more sketches were present in this phase in the UK participants' submissions, and were normally sketches of existing products and shapes from daily life, etc. They also tended to use more pictures from the internet. This also illustrated that the UK students tended to think through sketches and pictures compared with their Chinese counterparts.

Interestingly, the differences in the way of representing the research information between the UK and Chinese groups contradicted some of the conclusions from cross-cultural studies. According to Chiu (1972), Lin (1938) , Northrop (1946), Rau et al. (2004), etc., the Chinese way of thinking tends to be synthetic, concrete, and remain within the periphery of the visible world; whilst the Western way, which was represented by the Americans, was interpreted as analytic, abstract and imaginative and beyond the realm of the immediately apprehended. However, the situation was almost reversed in this study, the UK participants tended to use more concrete elements such as sketches and pictures whilst the Chinese students tended to use more abstract information such as literal illustrations.

6.5.2.2 Differences in the Phase of Development

The material in this phase from the report was mostly sketches and they constituted the main body of the design process. From the statistical test of the numbers of coding units in this phase, in Project 1, the coding of problem + solution from the '2+2' group was significantly lower than that from the UK group and very close to the CN group. This also confirmed the conclusion from the observation that the '2+2' students tended to produce much fewer sketches in the design studio. However, as time went by, when it came to Project 4, the statistical test results showed that using the same coding, there was a significant difference between the CN and the UK group; the performance of the '2+2' group tended instead to be very close to the UK group. The sketches, in this study were coded as units of sketch, stood for the cognitions that emerged in the design process. The differences in the coding suggested differences in the design cognition. This result indicated some change in the '2+2' students' design cognition during the period from Project 1 to Project 4. It also suggested that besides the cultural background, there were other factors that influenced the performance of the design process. According to the observation, the reason could be partly attributed to the interactions between the UK and '2+2' groups in the design studio. The '2+2' students acquired from their communication with their UK colleagues their way of presenting the design process. They also learned

from the 'high mark' submissions that more sketches gained higher marks. Therefore they consciously sketched more for their reports.

On the other hand, the communication with the tutors also changed some of their design behaviours. Besides the course tutors from the university, in the design studio of UK campus, there were also three external tutors who were design practitioners from the local design industry. Whilst for the Ningbo campus, the majority of the external tutors were Chinese and from the local design industry. The tutors' way of interpreting and presenting design influenced the students quite a lot. For the '2+2' students, their unique ways of design were formulated under such a comprehensive environment, therefore in their submissions they presented different styles compared to the CN group. They tended to produce more sketches which also formulated more design ideas. A further study in the next chapter that investigated the design process of UK and Chinese design practitioners explored the influences of culture on the numbers of concepts generated in the phase of development in more detail.

6.5.3 The differences shown in the design from the semantic word cloud analysis

The present study used the method of semantic word cloud analysis to explore the specific ways in which the two groups of participants constructed each design task, which also addressed the design attributes in aspects of aesthetics, ergonomics and creativity that showed in the design representations.

From the point of view of the whole design process, it is clear that the two groups had different ways of constructing the whole design process. A typical example from Project 1 was for the design of 'garden lighting' the '2+2' students tended to perceive the 'garden' and 'lighting' as two separate concepts to develop their design ideas, whilst for the UK group, it was considered as a whole complete idea. The reason for this difference could be attributed to the different interpretation of the concept of garden as mentioned in the result of observation in 6.4.1. The unfamiliarity of garden culture in urged the '2+2' students to explore it in more detail compared to their UK counterparts. This kind of situation could

be interpreted by the different cognitive styles suggested by Chiu (1972) and also confirmed by many other academics (Yee-Yin Choong & Salvendy, 1999; Gelfand & Kashima, 2015; Imai et al., 2016; Ishii, 2013; L J Ji et al., 2000; Li Jun Ji & Yap, 2016; Nisbett et al., 2001). In his article, Chiu concluded that the Chinese cognitive style was relational-contextual, which means to classify stimuli on the basis of their interrelationships and thematic relationships. In this study they had a tendency to interpret the relationship between the 'garden' and 'lighting' instead of taken them as one unit. On the other hand, the UK participants' performance echoes with the American cognitive style, which tends to classify stimuli on the basis of functions or inferences made about the stimuli that are grouped together. For them, the 'garden lighting' was a group based on the unique function that was required by the design task. Another example of this type of differences in that, in Project 1, the '2+2' students tended to address 'material' and 'manufacture' separately; this changed a lot in Project 4, but compared to the UK group, who tended to address these two themes together, the difference was still quite significant. Similar differences could also be found in the theme of 'aesthetics' and 'material'.

For the aspect of ergonomics, from the words of 'height', 'size' and 'dimension' used by the two groups, it was interpreted that size and dimensions were very important in design for both groups. Furthermore, the two groups also paid great attention to 'safety' aspects. There were differences between the two groups in the words related to the 'ease' of design, i.e. 'easy', 'easily', 'simple', according to the word frequency test: for the '2+2' group, there were in total 28 words, while for the UK group the number was 64. Participant No. 3 (UK group) took simplicity as the main principle of designing in Project 1 and Participant No.1 emphasised the principle of 'less is more' from the Bauhaus school (Figure 6.27). It was obvious that the UK group was concerned more about applying simplicity in their designs. This result also echoes with the results of Study 1, which shows that the designs from the UK student designers tended to be much simpler.

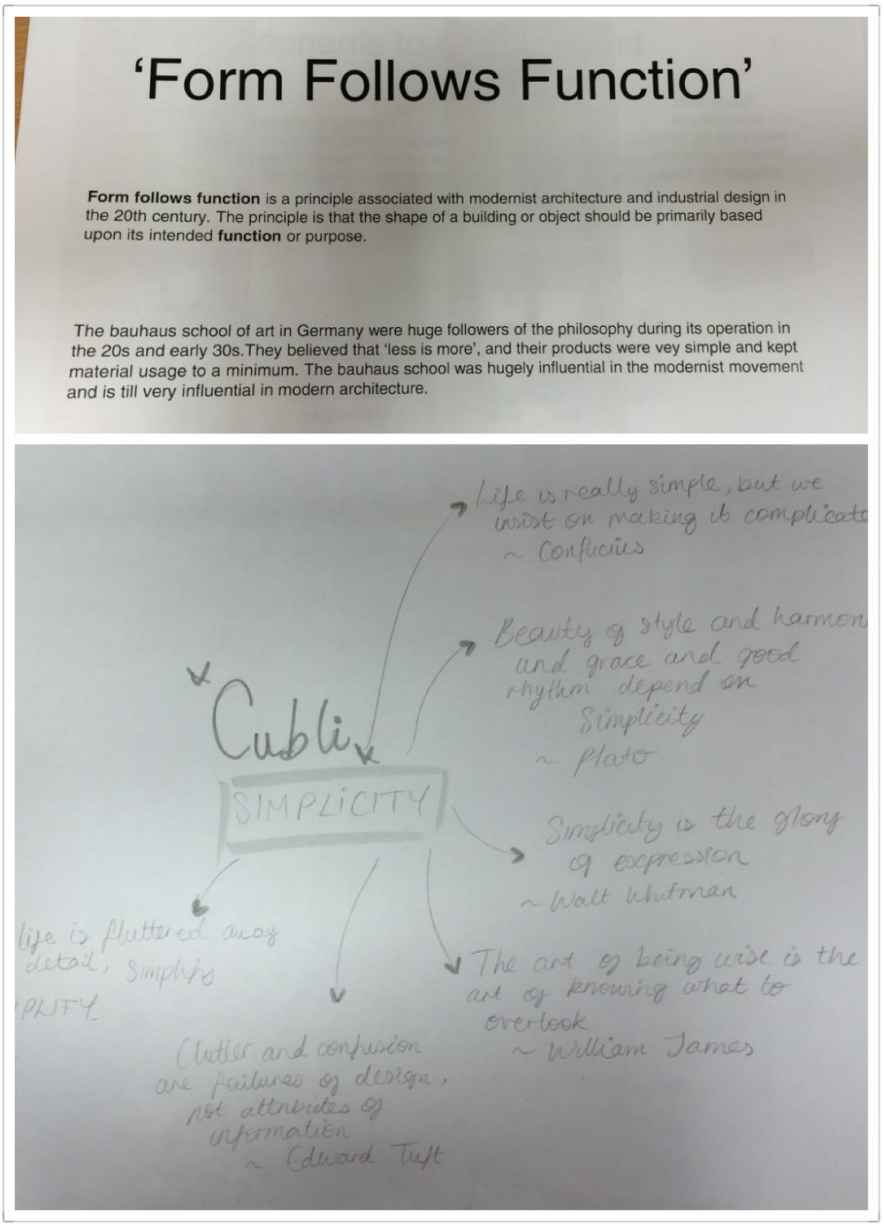


Figure 6.27 Sheets from the design report of the UK group

The aspect of creativity is difficult to measure, as the occurrence of the creative 'event' is uncertain and difficult to identify (Dorst & Cross 2001). The 'inspirations' that were labelled by the designers in the design text could be a clue to reveal the creative steps in the design process. According to the word frequency test, there were in total 81 'inspirations' in the submissions from the '2+2' group, and none from the UK group. Actually the UK students also showed the inspirations in their submissions, and most of the inspirations were shown as pictures or sketches such as shown in the sheets in Figure 6.28. But they did not label them as 'inspirations'. Another interesting thing is that, the inspirations

from the '2+2' groups were highly related to the use environment of the product, which was 'garden' for Project 1 and 'home' for Project 4.



Figure 6.28 A sheet from the design report of the UK group

A noteworthy thing is that, the word cloud analyses were conducted using the texts that were shown in the design report, which revealed a limited part of the design process. Another part of the information was carried by the pictures and sketches, which were vague and hidden. Therefore the differences shown in the results of the word frequency only stand for part of the reality. In order to get full information of the design process, it is necessary to observe the design process directly and have the designers interpret the process themselves. The study presented in the next chapter was conducted to address this issue.

6.5.4 The design of this study

This study was particularly designed to investigate the design process from the submissions of the student designers. There are some characteristics that are unique in such submissions: 1. It follows the requirements on how to present the design process, such as: it needs to present the research materials and certain dimensions for the final design, etc. 2. It does not necessarily present the actual

design process in a chronological order. The student could add any information to any part of the submission at any stage of their process. Also, the study on the design submission has its own drawbacks such as the design process being interpreted from the point of view of a third person that may not meet the actual intention manifested by the designer. The descriptivism design model used in this study was a compromise to address the particular issues in analysing student design submissions, as it overlooked the possible relationship between each unit, but looked directly at their relationship with the overall 'design problem – design solution' structure. Initially, the researcher tried to interpret the phase of Development by categorising design concepts; however it turned out to be very subjective when determining the relationship between each sketch and the reliability check index was quite low. The 'problem - solution' structure was finally proposed and it visualises the design process from a more abstract but also more straightforward and simpler way when doing the comparison.

The sample size of this study was relevantly small, with 11 from the UK, 6 from the '2+2' and 6 from Ningbo campus, China. This was due to the limitation of the available sources. The data collected from the design process was actually quite large, including 46 design submissions and a total of 1548 pages of material. The differences revealed were quite distinguishing given the small sample size. Possible future work can be proposed to investigate the differences between student designers with larger samples.

6.6 Conclusion

This study was conducted to investigate the differences in the design processes of the student designers with UK and Chinese backgrounds using a research model that illustrated the design process as a procedure from the design problem to the design solution. One of the significant findings from the study is that cultural background was found to have an influence in the performance of design: from the way they used sketching as a tool in the design process, from the numbers of sketches, which represented the design cognitions and also from the semantic word clouds generated from the texts of the design submissions. The comparison

between the two groups of Chinese student designers suggested that the performance in the design process could be influenced by other factors such as school education and peer influence. Such influences appeared to affect greatly the design process if only considering the numbers of sketches shown in the design report. However, it has a limited effect on the way that they use sketching as a tool in the idea development. The design processes in this study were the processes that were perceived by the researcher via the design submissions. Further studies are needed to investigate the perception of differences from the perspective of design practitioners from the design industry to validate and further explore the differences. The interpretation of the designs should be elicited from the designers themselves.

7 CULTURAL DIFFERENCES IN THE DESIGN PROCESS – A STUDY OF DESIGN PRACTITIONERS

7.1 Chapter overview

This chapter represents a protocol study with both a group of UK and Chinese professional designers. It used the same design model as in the former chapter, which decomposed the design process into three phases: Phase 1 – assimilation + general study, Phase 2 – development and Phase 3 – communication. This study was mainly focused on Phase 1 and 2. It used the data from video protocols, texts & sketches and the transcript interviews to analyse the design process in a comprehensive way.

7.2 Introduction

This chapter describes a set of protocol studies of a group of experienced industrial designers, which aims to compare the design processes of UK and Chinese design practitioners and validate the results from Study 3. Following the findings of the study with the design students, which indicated that there were notable differences between the UK and Chinese designers in Phase 1 (assimilation + general study) and Phase 2 (development in their way of constructing design problems) in their use of sketching and in the numbers of sketches, the study presented in this chapter explored the potential cultural differences using the same research model (Figure 7.1).

Participants in this study were asked to finish a design task within a set time period, and therefore the empirical data on design processes were obtained from direct observation together with the individual designer's personal interpretation and confirmation afterwards. This is the main difference from the former study which interprets the design process mainly from the researcher's point of view.

7.2.1 The role of sketching in design

In this study, sketches were one of the main sources that were explored to understand the cognitive processes taking place in the design activities. The role of sketching in design and some relevant literature were presented in section 2.2.4. It has been noted that, during the design process, the complexity of the sketches varied at different stage (Rodgers et al. 2000; McGown et al. 1998; Tovey et al. 2003). This study used the different levels of complexity to investigate and compare the relevant differences in the design processes as shown in the design representation. Also, the type of sketching varied throughout the design process to meet different purposes and different types of sketches have been identified by researchers (Ferguson, 1992; Seitamaa-Hakkarainen & Hakkarainen, 1995). This study identified two types of sketches, namely the thinking sketch and the prescriptive proposed by Seitamaa-Hakkarainen & Hakkarainen (1995) to investigate the differences in the UK and Chinese designers' sketches.

7.2.2 Research model

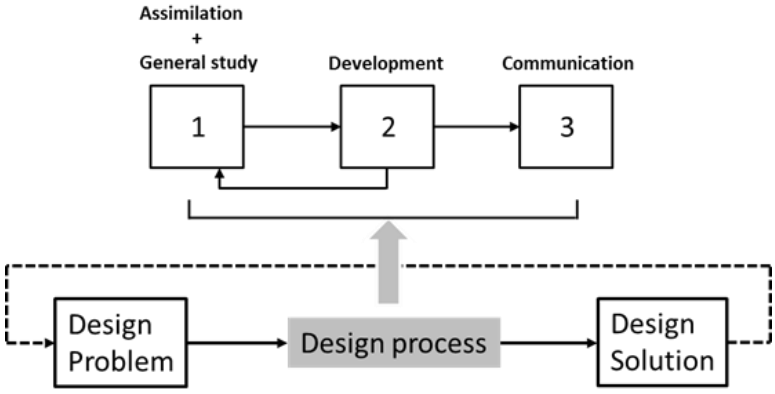


Figure 7.1 research model of design process for Study 3

The research model in this study is the same one used in the study introduced in the last chapter (Figure 7.1). The whole design process was divided into three phases: Phase 1 – assimilation + general study, Phase 2 – development and Phase 3 – communication. The definition of each phase can be found in Table 6.1. This study focused on Phases 1 and 2 for two reasons: firstly, the differences found in Study 3 were mainly in these two phases; secondly, in real design practice, the Phase 3 of Communication refers to the stage when a designer communicates

the solutions to people in the design team or to the clients, which is out of the scope of the present study. This study focused on the design process from the stage when an individual designer gets the design task to the stage when a design solution is produced. It is the cognition process from the design problem to the design solution that the study aims to explore.

The overall design process was still interpreted as a progression from the design problem to the design solution as presented in the model. However, instead of decomposing the design process into units of problem, solution and problem + solution in Study 3, the present study tried to represent the real design processes as accurately as possible. In Phase 1, it would be mainly about representing the actual ways the designers investigated the design problem, which would refer to how they define the design problem, how they interpret the design requirements and constraints, etc. In Phase 2, based on the observations and the interviews, it would be possible to identify the actual design ideas that appeared during the process and the way it was developed.

Based on the findings of Study 3, it was expected that in Phase 1, there would be differences in the form of representations the designers used and the way they construct the design task, i.e. the patterns they shown in the representations; in Phase 2, there would be differences in the way the designers use sketching and the numbers and content of sketches and concepts developed. However, as Cross (2004) argued, “a novice undergoes training and education” and then “at some later point becomes an expert”. The process of accumulation of experience, which is a “vital part of the transformation to expert”, is the main differences between the student designers and professional designers. It is reasonable to assume that the differences found in student designers could be either magnified or diminished with an extra variable of experience. In this study, it was assumed that culture plays a vital role also in the design process of professional designers of. The objectives and hypotheses of this study were defined based on this assumption and are presented in the following sections.

7.2.3 Aim and Objectives

The results of Study 3 showed the differences in the use of sketches, in the numbers of design units (problem, problem + solution, solution) which represented the cognitive differences and also the way of constructing the whole design task (from the semantic word cloud analysis). The overall aim of the present study was to validate these differences with the design practitioners. The detailed objectives were as listed below:

1. To investigate the use of sketches throughout the design process from the UK and Chinese design practitioners.
2. To investigate the differences shown in Phase 1, namely the way the designers interpret and construct the design problem.
3. To investigate the differences shown in Phase 2, namely the way the designers generate the developing design concepts.

7.2.4 Hypotheses of study

Based on the results of Study 3, three hypotheses were developed for the present study

1. Chinese designers tend to use sketches more for recording design ideas while the UK designers tended to use them for both recording and developing ideas.
2. UK and Chinese designers will focus on different aspects of the design attributes in Phase 1 when constructing the design problem.
3. UK designers, compared to their Chinese counterparts, will present more sketches and also more design ideas in the development stage.

7.3 Method

7.3.1 Participants

Given that the aim of this study was to validate the findings from the former study with design students, the participants were focused on designers who had experience in the industry as a product designer. There were three main sources

of participants. Some of the participants were recruited from designers who worked as external tutors in the design studio of the Course in Product Design and Manufacture (PDM) in the UK and Ningbo campuses of the University of Nottingham. Some were recruited via the email list of the graduates from PDM. Some were introduced from the acquaintances of the existing participants who also worked as product designers.

In total there were 20 designers recruited, 10 from the UK and 10 from China. Figure 7.2 shows the mean age and experience in product design of both groups. It can be seen that the UK participants were older and more experienced than their Chinese counterparts. For the UK designers, the youngest one was 22 and the oldest 58, with a mean of 41.10 (SD: 14.02). For the Chinese designers, the youngest was 24 and the oldest 34, with a mean of 28.30 (SD: 3.40). Regarding the experience in product design, the average experience time of the UK groups were 13.32 years (SD: 11.98) and the Chinese group 5.05 years (3.93). The designer with the longest experience of the UK group had been working in the area of product design for about 36 years (working firstly as a designer and then a lecturer in product design in a university and in the meantime as a part-time freelance consultant in product design). For the Chinese group, the one with the longest experience (13 years) was also a lecturer in product design in a university (10 years) and simultaneously working as a freelance consultant. Two other participants from the UK groups were working as lecturers in Product design in a university. All the other participants were working in design consultancies. Two from the UK groups were new beginners (1 month experience each) and two from the Chinese group (7 months and 11 months respectively). There was only one female designer in each group, both of whom were new beginners (UK: 1 month, Chinese: 7 months).

The study was designed based on the relevant ethical principles and has been reviewed according to the ethical review processes in place at the University of Nottingham and Faculty of Engineering. The relevant participant information sheets and consent forms can be found in Appendix 7A.

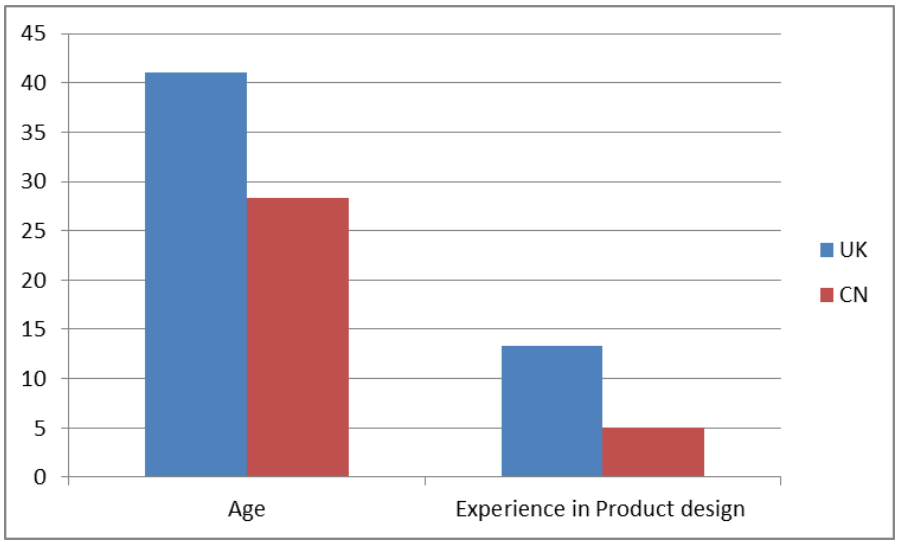


Figure 7.1 Mean age and experience in Product Design of UK and Chinese participants (in years)

7.3.2 The protocol study

7.3.2.1 The design task

The task developed for this study was designed to be realistic and appropriate for both UK and Chinese participants, not too simple or complex, and feasible in the time available. The task was to produce a condiment counter for a local Starbucks store. Starbucks was chosen as the object of the design task due to their popularity in both the UK and China. The design of a condiment counter requires the consideration of a variety of aspects such as ergonomics, aesthetics, functionality etc. The design brief also introduced briefly, the background of Starbucks, such as its history (in the UK and in China respectively) and its design philosophy (which was cited from its official website). Each participant was allowed up to 1.5 hour for the design task to produce a design solution. The brief was written in English and Chinese for the respective participants.

Design task

1. Context

Starbucks is the largest coffeehouse company in the world. Starbucks coffeehouse serves hot and cold beverages, whole-bean coffee, micro-ground instant coffee, full-leaf teas, pastries, and snacks. Most stores also sell pre-packaged food items, hot and cold sandwiches, and items such as mugs and tumblers.

Starbucks in the UK:

In May 1998, Starbucks successfully entered the European market through its acquisition of 65 Seattle Coffee Company stores in the UK. Up to 24 Jan, 2015, there were 799 Starbucks in the UK.

Starbucks in China:

Since the opening of the 1st Starbucks store in Taiwan in March 1998 , Mainland China at the China World Trade Building in Beijing in January 1999, Hong Kong in May 2000, and Macau in August 2002, the growing interest and appreciation of high quality coffee and the Starbucks Experience by Chinese consumers has produced steady store expansion throughout China. In the Mainland region with the fastest growth, there are over 1000 stores in 60 cities including Beijing, Tianjin, Shanghai, Guangzhou and Shenzhen.

Design philosophy of Starbucks

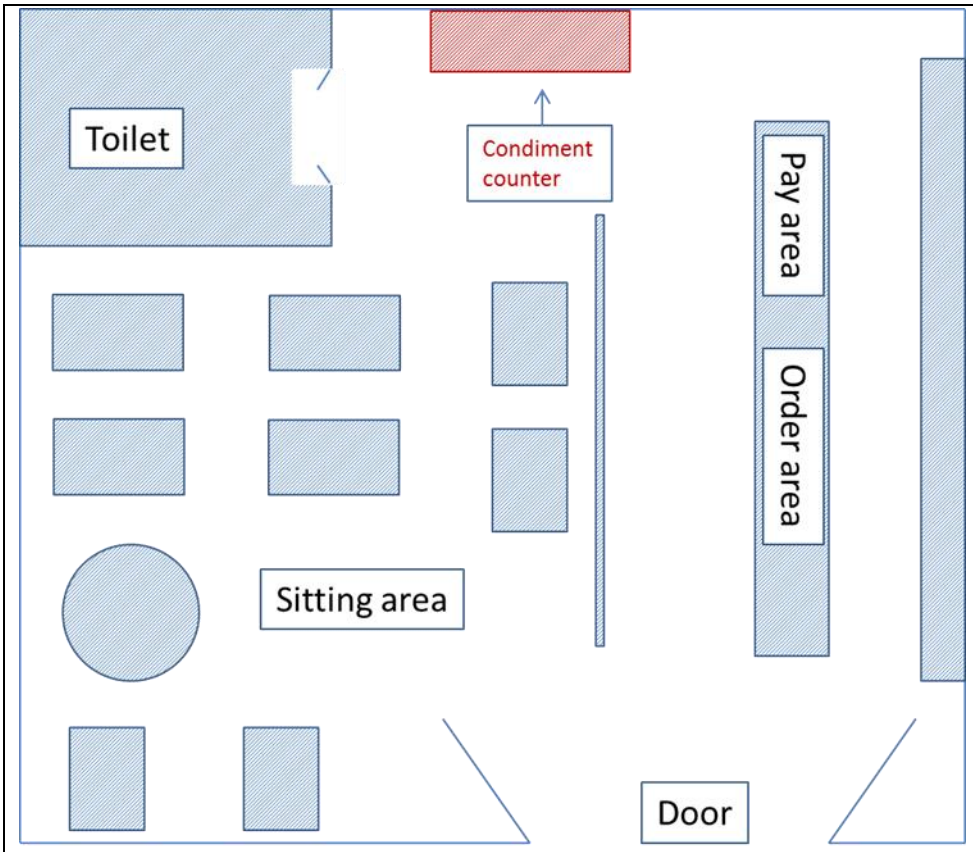
"Across the world our store designs are rooted in our coffee heritage, and in our Starbucks™ Shared Planet™ community involvement (to do business in ways that are good for people and the planet) and environmental responsibility goals. So our designs reflect the character of a store's surrounding neighbourhood and help reduce environmental impacts."

"Our new approach to store design means that our designers are looking at each store individually to ensure that it looks distinctively local. This represents a new level of coffeehouse comfort, meaning that no two Starbucks will ever be entirely the same."

2. Task

You are asked to design a condiment counter for a Starbucks coffeehouse that is located in your city.

The layout of the inner space in the Starbucks:



The condiment counter is used for:

1) Placing pots of hot water, milk

2) Placing bottles of spices

3) Placing sugars, creamers

4) Placing tissue, straw and stir sticks etc.

Think about the needs and the flow of the customer inside the store. Make sure the design meets the customer's needs as well as the overall design philosophy of Starbucks.

Figure 7.2 The design task

7.3.2.2 The procedure of the study

In a real design project, a designer needs to do lots of work during the whole design process, such as field trips, user investigations, brainstorming with team members, communicating with clients, etc. These activities take place mostly in the phase of Assimilation + General study, which is for accumulating the information to investigate the possible solutions (Lawson, 2006). In the present

study, due to the limitations of time and resources, it was not feasible to cover all the possible means that the designer would use for information accumulation. As an alternative, a laptop with access to the internet was provided for any possible information search. Basic tools such as marker pads, marker pens (5 levels of cool grey), fine liner pens, ball pens, pencils and A4 sheets were provided. (See Figure 7.4)

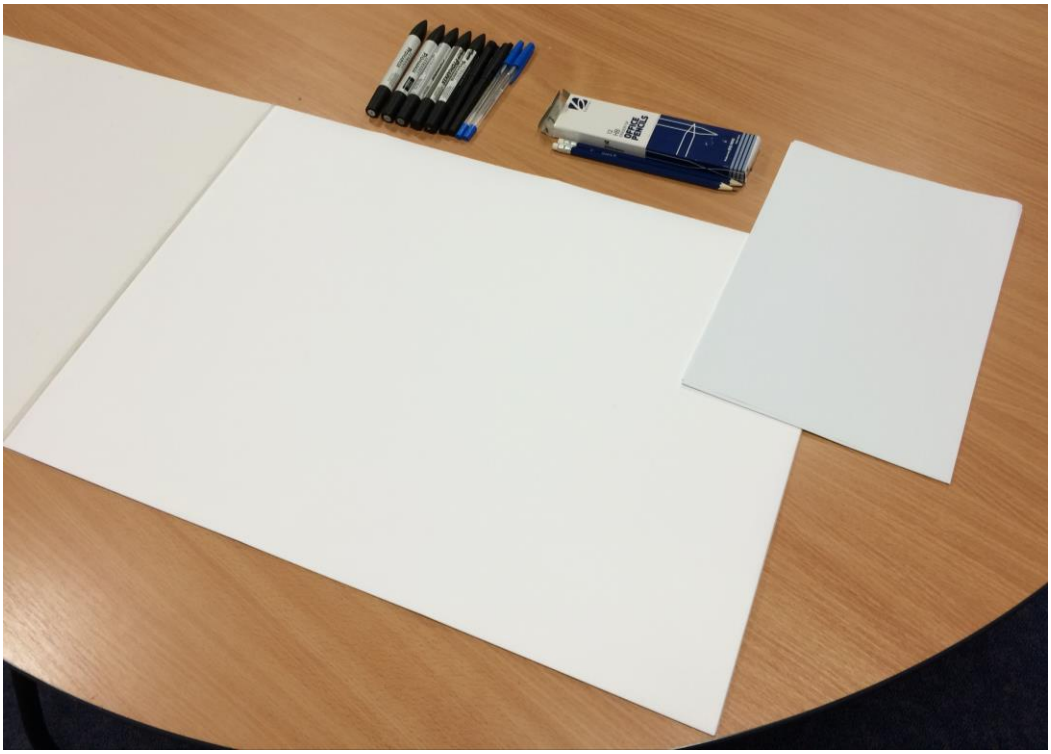


Figure 7.3 Tools used in the study

The study started with a short questionnaire to collect basic demographic information. Then the researchers introduced the design task and showed the participant the design brief. They were asked to follow their normal design routine as much as possible to finish the design task and presenting a design solution within 1.5 hours. After the design task, the researcher asked the participants some questions based on the design process. The questions were designed with two objectives: 1. To clarify the information that was expressed in the design representations; 2. To elicit other information that was not presented in the sketches. The questions were listed as follows:

Table 7.1 Questions asked in the interview

1	How many ideas? How was it developed? Number the steps. Talk through the process.
2	What is the purpose of information research in your design process?
3	Where did your inspirations come from?
4	How often do you go to Starbucks? What is the role of coffee in your daily life? And in this design task?
5	Are you satisfied with your final design?
6	To what extent did the design process fit to your usual design activities (what percentage)? What are the main reasons for the differences?
7	Did you feel the time pressure? What is your time management target?

The first question was to understand the sketches and was asked in the form of the researcher guiding the participant to go through the whole process and to clarify any information that was not clearly presented in the sketches, such as how many design ideas came up (including some hidden ideas that were not clearly presented in the sketches), what was the consideration of each sketch, what was the motivation for them to change from each sketch, where were the inspirations from for each idea, etc. The following questions were to understand the other information which was not presented in the sketches, it could be any background knowledge, habitual thinking, personal design style, the feeling about the time pressure, etc. The questions also concern the participants' former experience with Starbucks and coffee, considering their different roles in the UK and Chinese people's daily life.

The whole process took about 2 hours and was recorded on video for later analyses. The UK sections were conducted in English and the Chinese sections were conducted in Chinese and all the material was translated into English by the researcher. The participants were paid £20 (in UK) or ¥120 (in China) each as an incentive for their time.

7.3.3 The method of analysis of the design process

The data in this study was mainly from three resources: 1. video protocols, 2. texts and sketches produced by the participants during the design process, 3. interview transcription.

7.3.3.1 The division of the sketch sheets

The division of the sketch sheets in this study was similar to the former study. There were two main elements in the sketch sheets, namely the text and the sketches. The sketches were numbered in the order the designer drew them. The texts were transcribed and divided into small units based on their semantics. An example of transcription can be found in Figure 7.5.

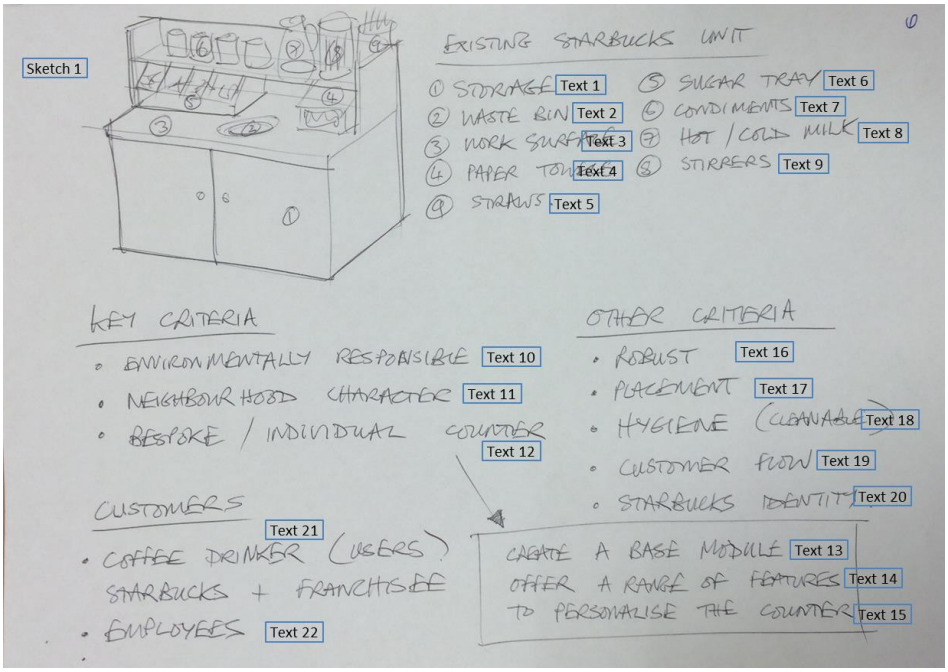


Figure 7.4 An example of division and transcription of one sketch sheet

7.3.3.2 The method of analysis on Phase 1 – Assimilation and general study

In Phase 1, which normally took place immediately after the designer was given the brief, the main task was to define the problem by accumulating and ordering information. The collected information was used as the resource of the inputs to generate the design problem and sometimes even to inspire some potential solutions. It is generally recognized that the design problem is always ill-defined and the design process always requires constant generation of new task goals and redefinition of task constraints (Akin 1986). However, many researchers still try to capture and define the nature of this process. Chandrasekaran (1990) specified the design problem by a set of functions, a set of constraints and a technology. In the design model of Ralph & Wand (2007) (Figure 7.5), the inputs in the design process were categorised into five types of objects, namely the

environment, goals, primitives, requirements, and constraints. The present study used these elements to summarise the information collected in Phase 1 of each designer, so as to compare their ways of constructing the process. According to Ralph & Wand's denotation and connotation of each element, the content of the elements in this study was defined as in Table 7.2.

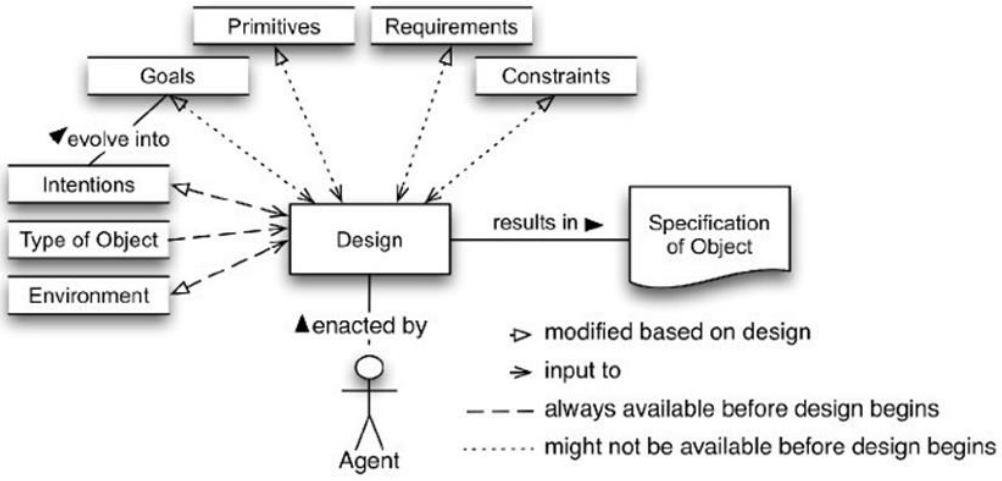


Figure 7.5 Context-level Conceptual Model of Design (as a verb) by Ralph and Wand (2007)

Table 7.2 The categories of the inputs

Input type	**Content**
Environment (object)	A local Starbucks store: local city, Starbucks
Goals	A condiment counter: placing, storing
Primitives	Aesthetics: colour, material, style, decoration, etc. Ergonomics: size & dimensions, safety, conveniences & ease, etc. Functionality: placing, storing, others, etc. Others
Requirements	Design philosophy of Starbucks: environmental consideration, locality, etc.
Constraints	The layout of the inner space of the Starbucks store, customer flow

The information, which was normally presented in three ways: the texts, the sketches, and the keywords in online search (recorded by the researcher), was the main subject of analysis in this Phase. They were categorised into each element of the inputs.

7.3.3.3 The method of analysis on Phase 2 – Development

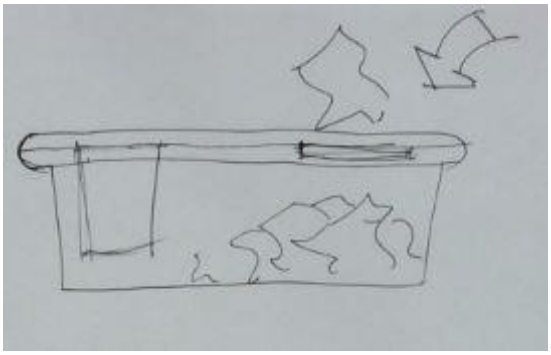
Phase 2 was mainly composed of sketches, sometimes also with texts to illustrate the sketches. For this study, the sketches were categorised into concepts that were explained by the designer during the interview.

In order to identify the differences between the sketches, the levels of complexity of sketches (Rodgers et al. 2000; McGown et al. 1998; Tovey et al. 2003) was applied in the analyses of Phase 2 (Table 7.3). Due to the limit of the task time and lack of size and dimension data, level 5 sketches were not suitable for the present study. Only the first four levels of complexity were used and examples of each level are given in Table 7.4.

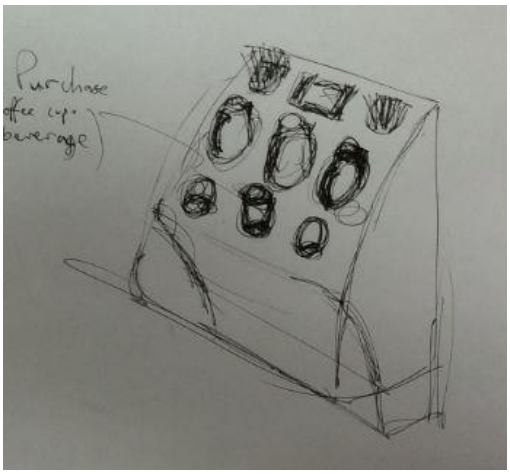
Table 7.3 Five levels of complexity of sketches

Complexity level 1:	Monochrome line drawing, no shading or colour, uniform line thickness
Complexity level 2:	Monochrome line drawing, no shading or colour. Line thicknesses vary to give emphasis. May include brief annotation.
Complexity level 3:	Monochrome with rough shading to suggest form. May be annotated.
Complexity level 4:	Line and shading, may include colour and graduation.
Complexity level 5:	Colour illustration to show what the product looks like. Colour, shading, shadows, annotations, dimensions.

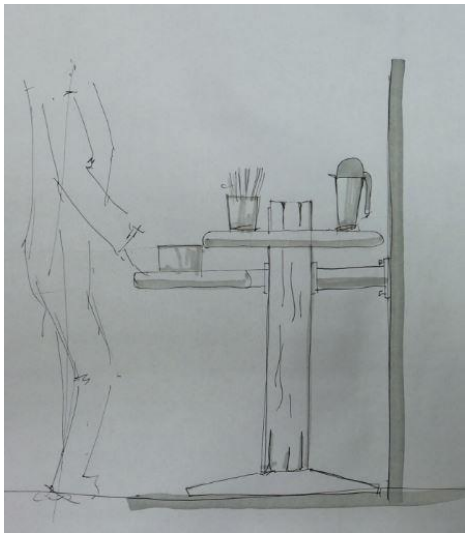
Table 7.4 Examples of sketches of each level

Complexity level 1:	

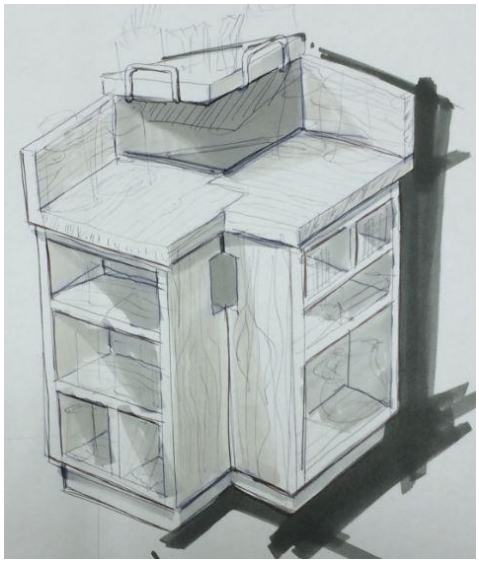
Complexity level 2:



Complexity level 3:



Complexity level 4:



Furthermore, based on the two essential functions of sketches in the design process, the sketches were also categorised into two types (Seitamaa-Hakkarainen & Hakkarainen 1995):

1. Thinking sketch, used to guide the design thinking, usually is an initial design unarticulated idea that is still under development;
2. Prescriptive sketch, presenting a further articulated and detailed design, usually with no further development at the present stage.

The development of each sketch was analysed by examining how it was produced via the video recording of the design process.

7.4 Results

7.4.1 Phase 1 – Assimilation and general study

7.4.1.1 Differences in the forms of representing

The form of represention here means the ways the designers used to show how they defined the design problem. As a stage of collecting and ordering information, normally in Phase 1 the elements that appeared in the sketch sheets were texts and sketches (see Figure 7.6 – 7.7). However, this varied between the designers. According to the observation in this study, the differences in the represention forms shown at this stage mainly consisted of four aspects: 1. Whether there is a textual representation of the design process of defining the design problem in the sketch sheets; 2. Whether the designer did an online search; 3. What elements they used in the representation: sketch or text; 4. Whether the designer drew on the layout map of the inner space on the Starbucks store (see Figure 7.8).

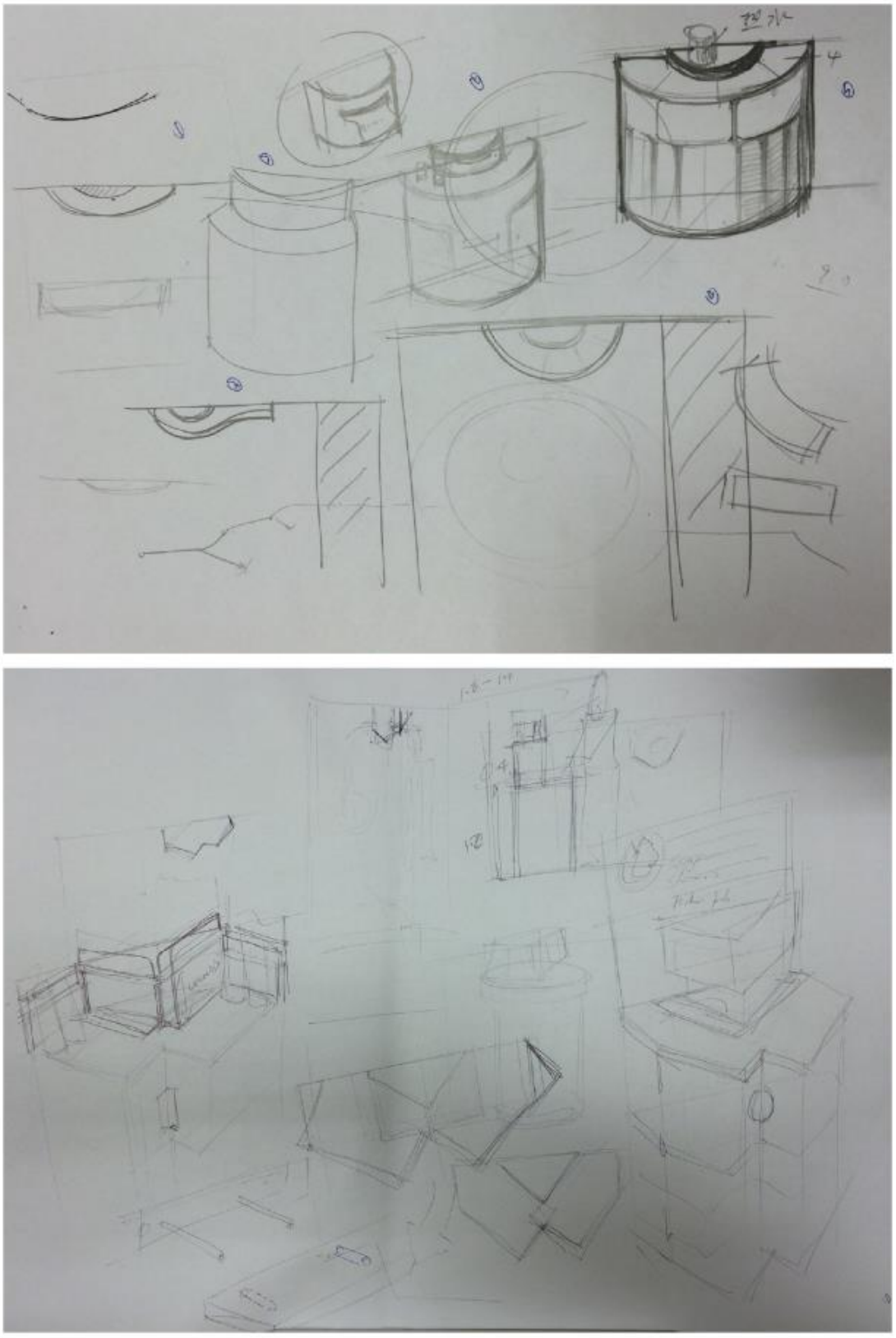


Figure 7.6 Examples of sketch sheets without textual representations in Phase 1

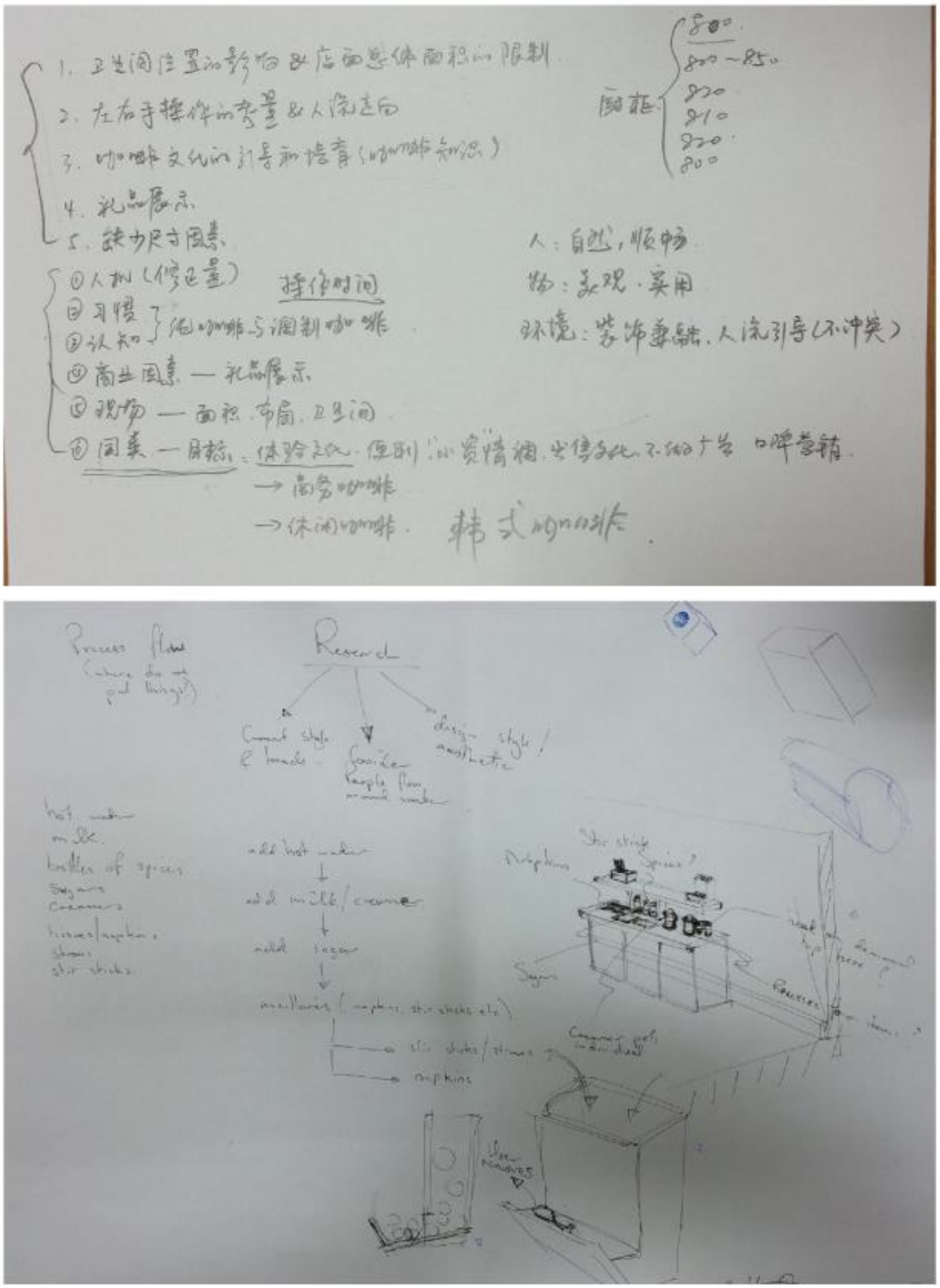


Figure 7.7 Examples of sketch sheets with textual representations in Phase 1

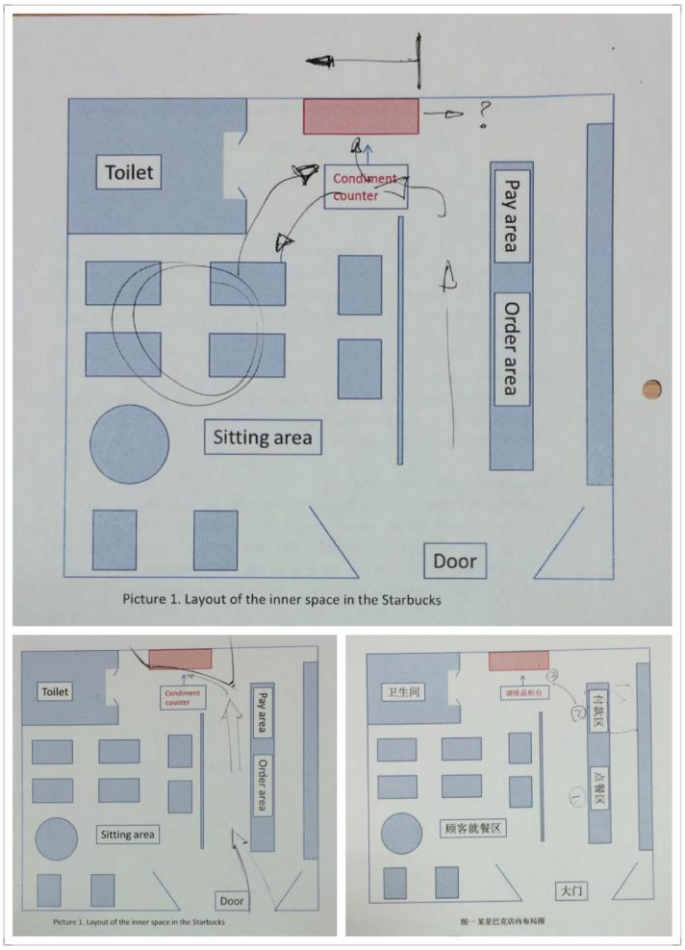


Figure 7.8 Examples of drawing on the layout map

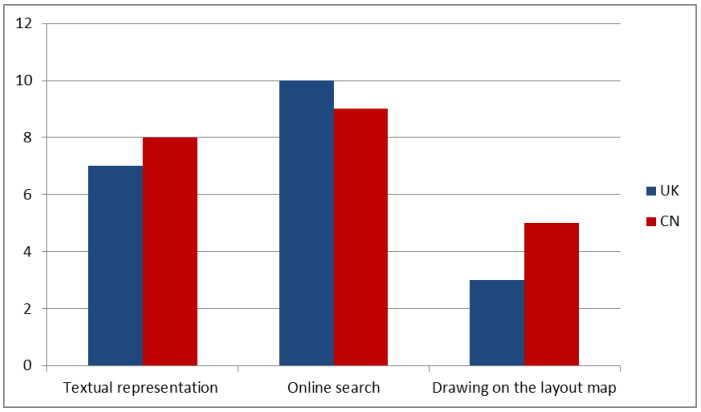


Figure 7.9 Numbers of designers with textual representation, online search and drawing on the layout map

Figure 7.9 shows the numbers of designers who did textual representation, online search and drawings on the layout map from the two groups. Also, the numbers of online search keywords, texts and sketches were summarised and compared (Figure 7.10). A one-way multivariate analysis of variance was run to

determine the effect of groups on the numbers of each form. Outliers were found in the data of "online search keyword" in UK participant No. 5 (7) and No. 9 (6) and in Chinese participant No.10 (29) and in "sketch" in UK participant No. 10 (7) and in Chinese participant No.8 (7). They were replaced with a number that is 1 more than the next most extreme value (7→5, 6→5, 29→12, 7→4 and 7→2 respectively) (Osborne & Overton 2004). Preliminary assumption checking revealed that the data from sketches of the UK group ($p < .001$) was not normally distributed, as assessed by Shaprio-Wilk test. The test was run regardless given that the one-way MANOVA is fairly robust to deviations from normality(Khan & Rayner 2003). There were no univariate or multivariate outliers, as assessed by boxplot and Mahalanobis distance ($p > .001$), respectively; no clear linear relationships for the data from the UK group were found, but the analysis was run given this; no multicollinearity, online search keyword & text ($r = .084$, $p = .726$), online search keyword & sketch ($r = -.369$, $p = .110$), text & sketch ($r = .319$, $p = .170$); and there was homogeneity of variance-covariance matrices, as assessed by Box's M test ($p < .001$). The differences between the groups in the numbers of representing forms were statistically significant, $F (3, 16) = 3.595$, $p = .037$; Wilks' $\Lambda = .597$; partial $\eta^2 = .403$. Follow-up univariate ANOVAs showed that the numbers of sketches of the UK group was statistically significantly higher than that from the Chinese group ($F (1, 18) = 8.018$, $p = .011$; partial $\eta^2 = .308$).

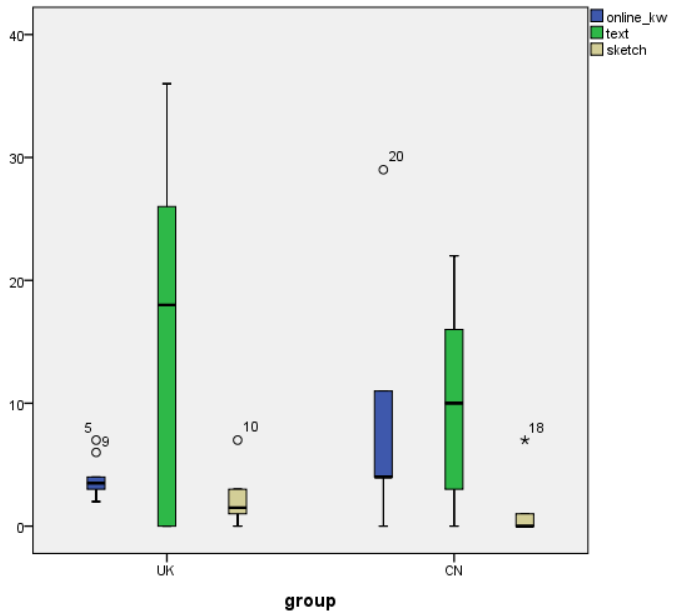


Figure 7.10 Numbers of representing forms of the two groups

7.4.1.2 Differences in the content of representations

This section shows the results of the analyses on the content of the texts and sketches, using the input categories from the model of Ralph & Wand (2007). The inputs, which include texts, sketches and keywords used in online search, were categorised to the detailed definitions of each input element developed in the present study.

Table 7.5 Numbers of the inputs (in unit) in Phase 1 of each designer[8]

Subject	Environment			Goals			Primitives						Requirements			Constraints			Total
	Local city			Starbucks			Condiment counter			Aesthetics			Ergonomics			Functionality			Environmental consider			Localization			Layout map			
																Required			Others									
	K	T	S	K	T	S	K	T	S	K	T	S	K	T	S	K	T	S	K	T	S	K	T	S	K	T	S	
UK 1				1						2						2	7									2			17
UK 2					1		3			3	7		1	2			8			1			6				1			32
UK 3				2	2		1										10													15
UK 4				2			1																					2		6
UK 5				1			5			1																		1		8
UK 6	1	4		1						4			1	2									9		1	4		3	2	33
UK 7	1			2			1																		1				1	6
UK 8	1	8					2			1							8					1	16		1	8			1	47
UK 9				1	1		4	4		9						1	5			1			4							30
UK 10		4		1			1	4			6			12			1	5		7	1		2			4				49
Mean		1.90			1.50			3.00			3.40			2.10			4.70			1.00			3.80			1.90			1.44	24.60
SD		3.11			1.08			2.49			3.89			3.84			4.22			2.49			5.59			3.11			1.51	16.41
	K	T	S	K	T	S	K	T	S	K	T	S	K	T	S	K	T	S	K	T	S	K	T	S	K	T	S	K	T	S	
CN 1				1	4		2	4					1	4						3								2		21
CN 2		1					3									1	1	1								1		1		9
CN 3	3	5		5	1		2	1								1									3	5				26
CN 4		3																								3				6
CN 5					1		2	2						1														1		7
CN 6	1	3		10	4		7										1	1							1	3				30
CN 7		3																							3					6
CN 8				2	8			1								2		5					5					1		24
CN 9		2		9	2		1	1			4			3						3						2		1		28
CN 10	9	2		9	8		11	3			1						3			4					9	2		1		62
Mean		3.20			6.40			4.00			0.50			0.90			1.50			1.00			0.50			3.20			0.70	21.90
SD		3.68			6.31			4.22			1.27			1.73			2.27			1.63			1.58			3.68			0.67	17.08

Table 7.5 shows the numbers of the inputs from each designer. The numbers of the input reveals the emphasis the designer put on this item when they were trying to define the design problem at this stage. There were some obvious differences as shown in the table. Firstly, there were differences in the element of **Environment**. In this design task, the environment had two aspects; one is the local city, which according to the brief is one of Starbucks' design philosophies to ensure the locality of the design of their store; the other environment is the

[8] In Table 7.3, T stands for text unit, K stands for online search keyword S stands for the sketch unit. The numbers in the columns of "Local city" and "Locality" refer to the same content.

intended context of use, namely the inner space of the Starbucks store. By referring to the means of the numbers of the inputs, the Chinese designers tended to pay much more attention to these two aspects compared to their UK counterparts, especially in the aspect of Starbucks as the use environment (6.40 Vs. 1.50). Another big difference was found in the element of **Primitives**, which in this study was defined as the aesthetics, ergonomics and functionality aspects of the design. The numbers show that the UK designers paid more attention on the aspect of aesthetics; seven of them mentioned this in their sketch sheets or searched online, whilst only two Chinese designers included this aspect at this stage. The UK designers also paid more attention to the ergonomics and functionality aspects. The functionality here was divided into two subsets, one refers to the required functionality, namely the placing and storing of the given items, the other aspect refers to the functionality that the designers added themselves out of the brief, such as the rubbish bin, lighting, gift display, etc. For the required functionality, the British designers mentioned this more in the text according to the mean numbers. For the functionality that was not required in the brief, three UK and Two Chinese designers mentioned this at this stage. Another difference found was that, for the element of **Requirements**, the two groups of designers displayed differences of emphasis: the British designers focused more on the environmental consideration from the Starbucks philosophy, whilst the Chinese designers paid more attention to the localization aspects.

The two groups of designers also showed differences in the element of **Constraints**, which referred to the layout of the inner space of the Starbucks store and also indicated the possible directions of customer flow. It can be seen in the table that the UK designers tended to analyse the layout map by sketching while none of the Chinese designers drew the map of the inner store on their sketch sheet.

7.4.2 Phase 2 – Development

Phase 2 focused on the development and refinement of the tentative solutions. From the observation of the design processes, it was found that the two groups of designers displayed large differences in their ways of developing the solutions.

Table 7.6 Summary of sketches and concepts from the two groups

Subject	Total No of sketches	Design concept		No of sketches
UK1	28	5	C 1	16
			C 2	2
			C3 -1	2
			C 3 -2	3
			C 4	5
UK2	22	7	C1	8
			C1-1	1
			C2	2
			C3	1
			C4	2
			C5	2
			C6	6
UK3	18	4	C1	3
			C1-1	1
			C2	1
			C2-1	12
UK4	20	2	C1	1
			C2	19
UK5	13	2	C1	7
			C2	6
UK6	4	1	C1	4
UK7	27	4	C1	4
			C2	6
			C2-1	3
			C2-2	14
UK8	11	1	C1	11
UK9	19	2	C1	10
			C1-1	9
UK10	5	1	C1	5
Mean	**16.7**	**2.9**		
SD	**8.33**	**2.02**		
CN1	3	1	C1	3
CN2	23	2	C1	2
			C2	21
CN3	9	1	C1	9
CN4	9	1	C1	9
CN5	5	1	C1	5
CN6	11	1	C1	11
CN7	14	1	C1	14
CN8	24	3	C1	3
			C2	12
			C3	9
CN9	7	1	C1	9
CN10	13	2	C1	9

			C2	4
Mean	**11.8**	**1.4**		
SD	**7.02**	**0.70**		

Based on the observations and the interviews, the content of the sketches from the designers is concluded and categorised. The complete table can be found in Appendix 7B. Table 7.6 shows the number of sketches and concepts and also relationship between the concepts from each participant.

7.4.2.1 Differences in the numbers of sketches and design concepts

A one-way multivariate analysis of variance was performed to determine the effect of groups on the numbers representing form. One outlier was found in the data of number of sketch in Chinese participant CN8 (24) and was kept for the test as it was very close to the next larger number (23 of CN2) (Figure 7.12). Preliminary assumption checking reveals that the data from "number of concept" of the Chinese group ($p < .001$) was not normally distributed, as assessed by the Shapiro-Wilk test. The test was run regardless given that the one-way MANOVA is fairly robust to deviations from normality (Khan & Rayner 2003). There were no univariate or multivariate outliers, as assessed by boxplot and Mahalanobis distance ($p > .001$), respectively; there was approximately linear relationships between number of sketches and concepts in each group; no multicollinearity ($r = .744$, $p < .001$); and there was homogeneity of variance-covariance matrices, as assessed by Box's M test ($p = .006$). The differences between the groups on the numbers of sketches and concepts were not statistically significant, $F (2, 17) = 2.357$, $p = .125$; Wilks' $\Lambda = .783$; partial $\eta^2 = .217$. Follow-up univariate ANOVAs showed that the numbers of concept of the UK group was statistically significantly higher than that of the Chinese group ($F (1, 18) = 4.903$, $p = .040$; partial $\eta^2 = .214$) .

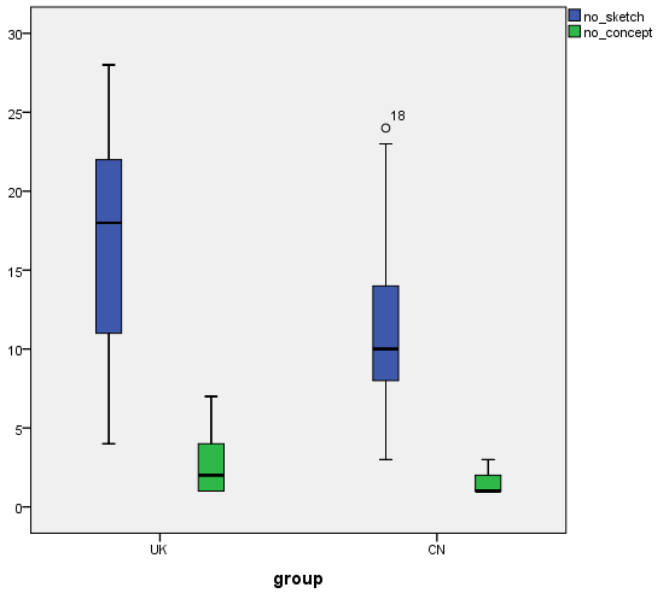


Figure 7.11 Numbers of sketch and concept from the two groups

7.4.2.2 Differences in the content of the sketches

Differences in the complexity levels

The numbers of sketches of each complexity level also varied with the designers. A one-way multivariate analysis of variance was run to determine the effect of groups on the numbers of sketches in each complexity level (Figure 7.12).

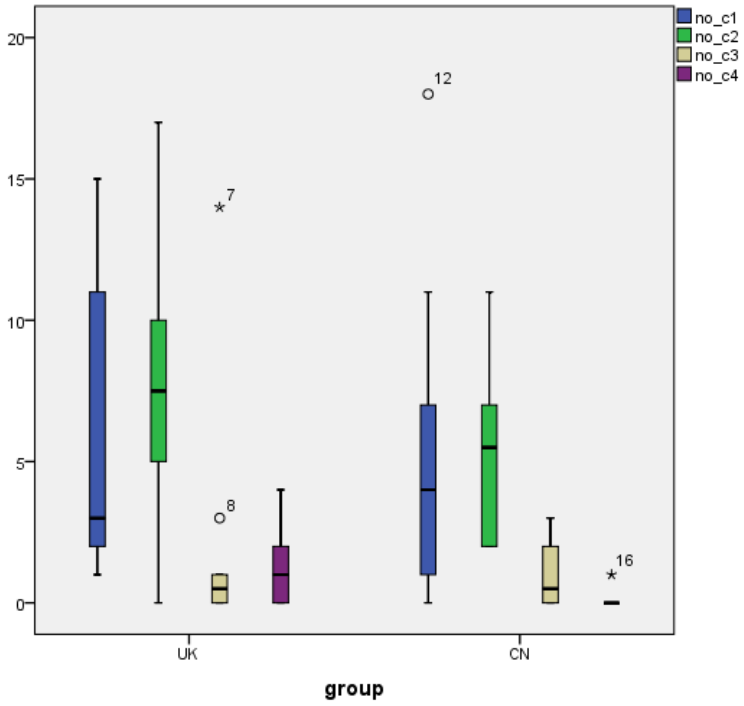


Figure 7.12 The numbers of sketches in each complexity level from each group

Outliers were found in data of UK7 and UK8 in complexity level 3 and in CN2 in complexity level 1 and in CN4 in complexity level 4. They were replaced with a number that is 1 more than the next most extreme value respectively (14→2, 3 →2, 18→12, and 1→0) (Osborne & Overton 2004). Preliminary assumption checking revealed that the data in complexity level 1 of the UK group ($p = .018$), in complexity level 3 of the UK group ($p = .008$) and Chinese group ($p = .014$) and in complexity level 4 of the UK group ($p = .028$) was not normally distributed, as assessed by the Shapiro-Wilk test. The test was run regardless given that the one-way MANOVA is fairly robust to deviations from normality (Khan & Rayner 2003). There were no univariate or multivariate outliers, as assessed by boxplot and Mahalanobis distance ($p > .001$), respectively; there were no clear linear relationships between some of the complexity levels, as assessed by scatterplot; no multicollinearity, complexity level 1 & complexity level 2 ($r = .247$, $p = .295$), complexity level 1 & complexity level 3 ($r = -.109$, $p = .647$), complexity level 1 & complexity level 4 ($r = -.109$, $p = .647$), complexity level 2 & complexity level 3 ($r = -.008$, $p = .973$), complexity level 2 & complexity level 4 ($r = -.299$, $p = .200$), complexity level 3 & complexity level 4 ($r = -.068$, $p = .774$); the SPSS did not compute Box's M test because there were fewer than two nonsingular covariance matrices. However, because there were equal sample sizes, the results were interpreted normally. The differences between the groups on numbers of sketch in complexity levels were statistically significant, $F (4, 15) = 5.516$, $p = .030$; Wilks' $\Lambda = .510$; partial $\eta^2 = .490$. Follow-up univariate ANOVAs showed that the numbers of sketches of complexity level 4 of the UK group ($F (1, 18) = 7.309$, $p = .015$; partial $\eta^2 = .289$) was statistically significantly higher than that of the Chinese group.

Differences in the type of sketch

The numbers of thinking sketch and prescriptive sketch also varied with the designers. A one-way multivariate analysis of variance was run to determine the effect of groups on the numbers of sketches of different types (Figure 7.13).

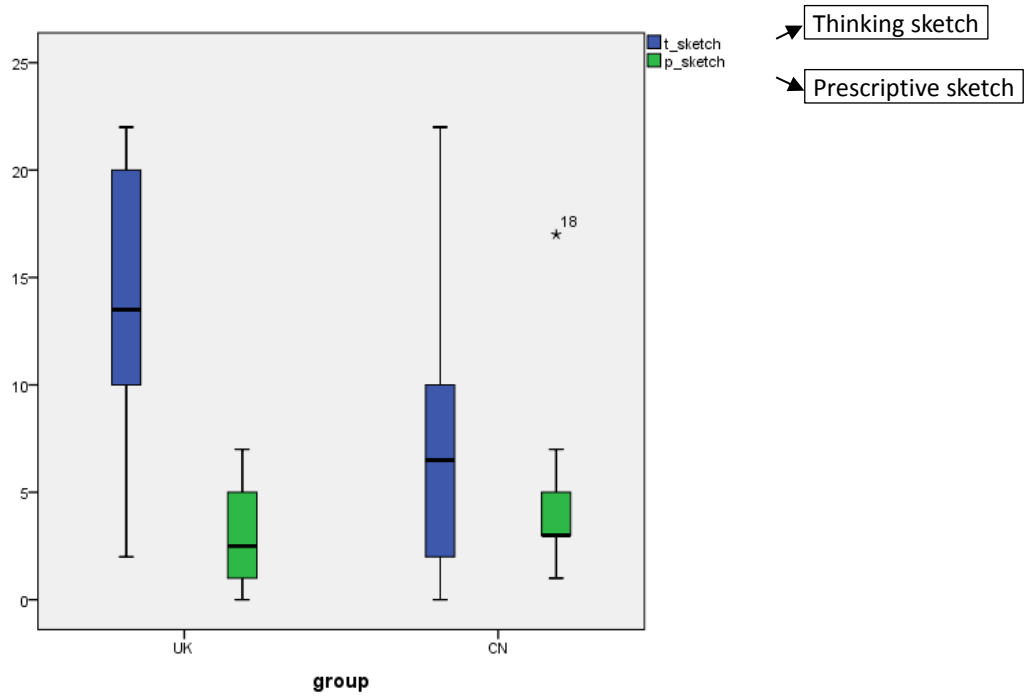


Figure 7.13 Numbers of sketches in each sketch type

Outliers were found in data of CN8 in Prescriptive sketches. It was replaced with a number that is 1 more than the next most extreme value respectively (17→8)(Osborne & Overton 2004). Preliminary assumption checking reveals that all the data was normally distributed (p >.05), as assessed by the Shapiro-Wilk test. There were no univariate or multivariate outliers, as assessed by boxplot and Mahalanobis distance (p > .001), respectively; there were no clear linear relationships between the two sketches, as assessed by scatterplot; no multicollinearity (r = -.146, p = .538); There was homogeneity of variances, as assessed by Levene's Test of Homogeneity of Variance (p > .05). The differences between the groups in numbers of thinking sketch and prescriptive sketch were not statistically significant, F (2, 17) = 2.201, p = .141; Wilks' Λ = .794; partial η^2 = .206. Follow-up univariate ANOVAs showed that the numbers of thinking sketches in the UK group (F (1, 18) = 4.290, p = .053; partial η^2 = .192) has a clear tendency of being statistically significantly higher than that of the Chinese group.

Differences in the relationships between the concepts

Table 7.7 also indicates briefly the relationships between the concepts from each designer, which were identified from the sketches and confirmed with the designers themselves during the interview by talking through the design process.

Look into details of the concepts, it is easy to see that, the UK designers, who produced more than one concept also tended to develop the concepts based on the former ones. For example, designer UK1 developed two sub-concepts in Concept 3, which was about adding a wall between the condiment counter and the toilet (Figure 7.14). He developed two sketches for both of the two sub-concepts. The same situation could also be found in the sketches from UK2, UK3, UK7 and UK9. On the other hand, for the Chinese designers who developed more than one concept, the connections between the concepts were not so obvious. For example, the designer CN8 produced 3 concepts: C1 is inspired by deduction of the size of the cabinet to create some different shapes; C2 was to make it as a table so that the ground of this area could be cleaned easily; C3 is to make it a modular system (Figure 7.15). According to the interview, the designer didn't think of connections between the different concepts, they just seemed to emerge separately, inspired by different things.

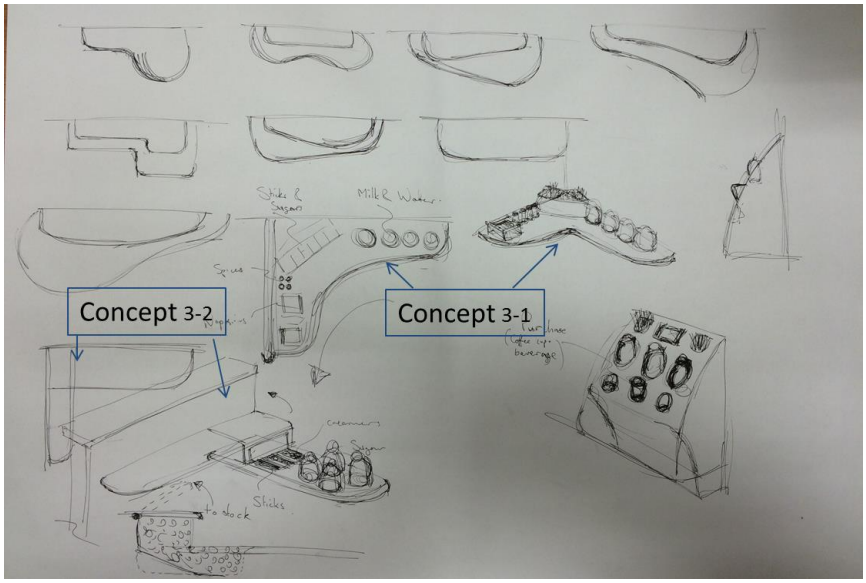


Figure 7.14 Example of sub-concepts from designer UK1

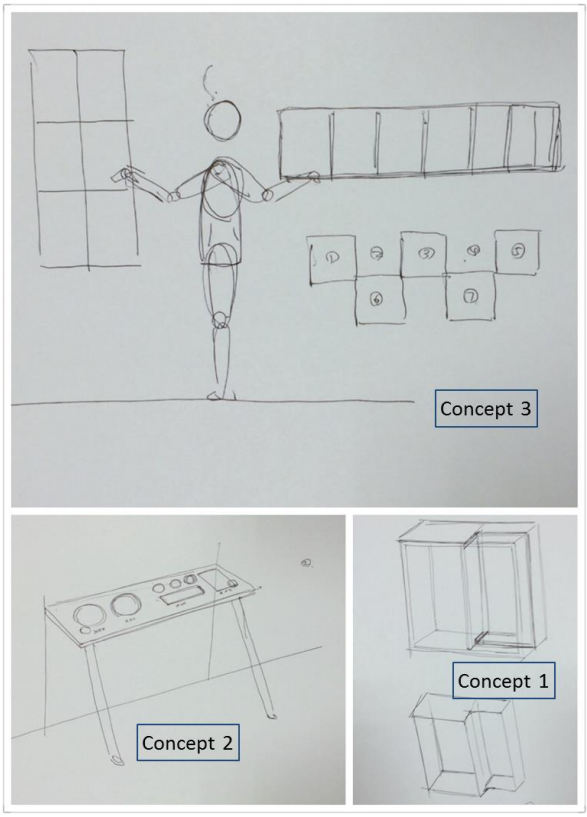


Figure 7.15 Example of three concepts from designer CN8

Table 7.7 summarises the results of the study. The conclusion drawn was that: in Phase 1, there were significant differences in the representation form between the two groups. The UK designers tended to sketch more compared to the Chinese designers. The Chinese designers tended to draw on the provided layout map more than the UK designers. They also had different focuses on the content of the representations. The Chinese designers focused more on the environment aspects and the localization part of the requirements aspects; whereas the UK designer focused on the primitives of the designs and the environmental consideration of the requirements aspects. In Phase 2, the UK designers tended to develop more concepts and also more complex sketches. They also showed a clear tendency of developing more thinking sketches compared to the Chinese designers. There were obvious relationships between the concepts from the UK designers; while for the Chinese designers, most of them tended to produce only one concept and for those who produced more than one concept, no obvious concept relationships were observed.

Table 7.7 Summary of results

Phase	subject		Result	Statistical test result	
Phase 1	Form of representation	Online search keyword, text, sketch,	1. There were significant differences in the numbers of online search keyword, text, sketch	One-way MANOVA	F (3, 16) = 3.595, p = .037; Wilks' Λ = .597; partial η2 = .403
			2. The number of sketch of the UK groups was significantly higher		F (1, 18) = 8.018, p = .011; partial η^2 = .308
		Drawing on the layout map	UK: 3; CN: 5		
	Content of representation	Environment	CN groups tended to pay more attention than UK group (environment of local city and Starbucks)		
		Primitives	UK groups tended to pay more attention than CN group (aesthetics, functionality and ergonomics)		
		Requirements	UK group focused more on the environmental consideration; CN group focused more on the localization aspects		
Phase 2	Numbers of sketches and concepts		1. The differences between the groups on the numbers of sketch and concept were not statistically significant	One-way MANOVA	F (2, 17) = 2.357, p = .125; Wilks' Λ = .783; partial η^2 = .217
			2. The numbers of concept of the UK group was significantly higher		F (1, 18) = 4.903, p = .040; partial η^2 = .214
	Content of sketches and concepts	Complexity level	1. There were significant differences in the numbers of sketch in each complexity level	One-way MANOVA	F (4, 15) = 5.516, p = .030; Wilks' Λ = .510; partial η^2 = .490
			2. UK groups had significantly more sketches in complexity level 4		F (1, 18) = 7.309, p = .015; partial η^2 = .289
		Type of sketch	1. The differences between the groups on the numbers of sketch types were not statistically significant	One-way MANOVA	F (2, 17) = 2.201, p = .141; Wilks' Λ = .794; partial η^2 = .206
			2. The number of thinking sketches of the UK group has a clear tendency of statistically significantly higher		F (1, 18) = 4.290, p = .053; partial η^2 = .192
		Relationships between the concepts	UK designers tended to produce more than one concept and also tended to develop concepts based on the former ones; no obvious relationship could be found on the concepts of Chinese designers who produced more than one concept		

7.4.3 Other issues in the design task

In the interview the participants were also questioned about the performance in the design task and also other relevant issues such as their experience with Starbucks, coffee etc. The results are presented as follows.

7.4.3.1 The role of online searching

Compared to the UK designers, the Chinese designers spent much more time online searching, but did not present much of the content on their sketch sheets. In the interview, the participants were asked what the purpose of their online searching was (the answers can be seen in Appendix 7C). Based on the answers, two main purposes of online searching were identified; to understand the design task and to gain inspiration. The Chinese designers tended to look for inspiration online more compared to the UK designers: for the UK group, there were only UK2, UK7 and UK9 who related this directly to inspirations, while for the Chinese designers, five of them (CN3, CN4, CN5, CN7 and CN10) mentioned the function of inspiring designs from the online searching.

7.4.3.2 Self-comments on the final design

In the interview the designers were asked to comment on their own designs. Table 7.8 shows that most of the designers were quite satisfied with their own work. Designer UK1 was the only one who said that he was totally unsatisfied with the design as he would never be satisfied with his own work. It was more a personal style rather than a comment on bad design. Designer UK2 was the only one who did not give a final design solution. Actually he developed seven design concepts during the process but at the end of the task he said that he needed more time to think about the final solution. Designer CN6 said that the design needed more improvement on its appearance.

7.4.3.3 Validity of the protocol study

In the interview, the designers were also asked about the similarity of their performance in the design task compared to their usual daily design activities. Table 7.9 shows the percentage of the similarity and also the missing part

Table 7.8 Designers' responses to the post-study question: "Are you satisfied with your final design?"

"Are you satisfied with your final design?"			
Participant	**Score/10 (from the designer)**	**Participant**	**Score/10 (from the designer)**
UK1	Not satisfied. (Would never be satisfied with design)	**CN1**	8
UK2	6 (need more time)	**CN2**	8
UK3	7	**CN3**	7
UK4	6	**CN4**	6
UK5	7	**CN5**	6
UK6	7	**CN6**	5-6 (need more details)
UK7	8	**CN7**	8
UK8	7	**CN8**	8
UK9	7	**CN9**	7 (need improvement in the appearance)
UK10	8	**CN10**	7

Table 7.9 Designers' responses to the post-study question: "To what extent did the design process fit to your usual design activities?"

Participant	**percent (the missing part)**	**Participant**	**percent (the missing part)**
UK1	Broadly speaking the same (more time in developing the concept; client interaction)	**CN1**	almost the same
UK2	90 (longer period)	**CN2**	60 (more research)
UK3	50 (need more time)	**CN3**	70 (more information about the product)
UK4	80 (more time in developing concepts)	**CN4**	70-80 (brainstorm)
UK5	80	**CN5**	70 (more research)
UK6	quite similar	**CN6**	80 (research, brainstorm)
UK7	exactly the same (less research)	**CN7**	80-90
UK8	quite similar (more research)	**CN8**	70 (would skip some parts in a real project)
UK9	95	**CN9**	80
UK10	50 (normally work for the public)	**CN10**	70 (more research, brainstorm)

compared to a real design task. Most of the designers claimed that their performance in the given task was very close to their normal work, especially if only taking consideration of the conceptual stage of the design process. Designer UK 10 claimed that he normally worked on public projects and there were

differences in requirements from the clients compared to the given task. For most participants, the relatively short time for the task was the main reason for the possible differences. Some also mentioned the teamwork part of a real design project where brainstorming and discussion with other team members or the clients was one of the missing parts. Designer CN8 was the only one who mentioned that he tended to show more of his design process for the sake of the study, as for his normal work he would skip some of the procedure.

7.4.3.4 Time pressure of the design task

The design task only allowed 1.5 hours to be spent on the design process, which was a relatively short period compared to real design projects. In the interview, the designers were also asked about their feeling about the time pressure to look into the possible influences on their performance. According to Table 7.10, only three UK designers claimed that they felt quite high pressure due to the limited time. Designer UK2 did not give a final solution as he wanted more time to think about it. Designer UK5 mentioned that the high pressure was probably because he was not sure what the researcher was expecting from his work. This kind of concern impacted on his performance. Designer UK9 said that he found he did not have enough time at the final stage when he wanted to draw everything nicely. On the other hand, designer UK10 mentioned that he used to participate in some similar short-period design projects in his work. From the overall point of

Table 7.10 Designers' responses to the post-study question: " Did you feel the time pressure? "

Participant		Participant	
UK1	No	**CN1**	No
UK2	It's tough and I know it's going to be tough.	**CN2**	No
UK3	A bit	**CN3**	A bit, spent too much time in research
UK4	No	**CN4**	No
UK5	Quite high	**CN5**	No
UK6	No	**CN6**	Normal pressure
UK7	No	**CN7**	No
UK8	No	**CN8**	No
UK9	quite high	**CN9**	No
UK10	Low pressure	**CN10**	No

view, the time pressure had very limited impact on the participants' performance.

7.4.3.5 Experience with Starbucks

Coffee plays a different role in the daily life of UK and Chinese people and Starbucks is also a brand from the West. The different experiences with Starbucks could also influence the designers' design process. In order to eliminate the possibility that the familiarity level of Starbucks might influence the route of information search, in the interview section, the participants were also asked how often they went to Starbucks. Table 7.11 shows that there were 3 participants from each group that indicated they rarely went to Starbucks and except for UK7 (2-3 in total) and UK9 (1/Y), the other participants visited Starbucks quite frequently. There was no obvious information which showed that the Chinese designers were less familiar with the environment of Starbucks.

Table 7.11 Designers' responses to the post-study question: "How often do you go to Starbucks?"

Participant	Frequency	Participant	Frequency
UK1	Rarely	**CN1**	2/M
UK2	1/D	**CN2**	Rarely
UK3	Used to be 1/W, now 1/M	**CN3**	2-3/M
UK4	3-4/W	**CN4**	2-3/M
UK5	Rarely	**CN5**	1/M
UK6	Rarely	**CN6**	1-2/W
UK7	2-3 in total	**CN7**	Rarely
UK8	1/M	**CN8**	3-4/M
UK9	1/Y	**CN9**	1/W
UK10	6/Y	**CN10**	Rarely

7.5 Discussion

The present study aimed to investigate differences in the design process of Phase 1 and 2 between the UK and Chinese professional designers, and also to validate the findings from the previous study which was conducted with student designers. According to the previous study, there were three main differences between the UK and Chinese student designers: 1. They had different ways of

perceiving and using sketches as a tool in aiding design activities; 2. They tended to produce different numbers of sketches, which was taken as the main index of interpreting the design process; 3. They had different ways of constructing the design problem. The three differences were also seen with the professional designers in the present study. The findings also confirmed the assumption that given the differences in design experience, culture plays a vital role also in the design process of professional designers. The findings are concluded and presented in the research model as shown in Figure 7.16.

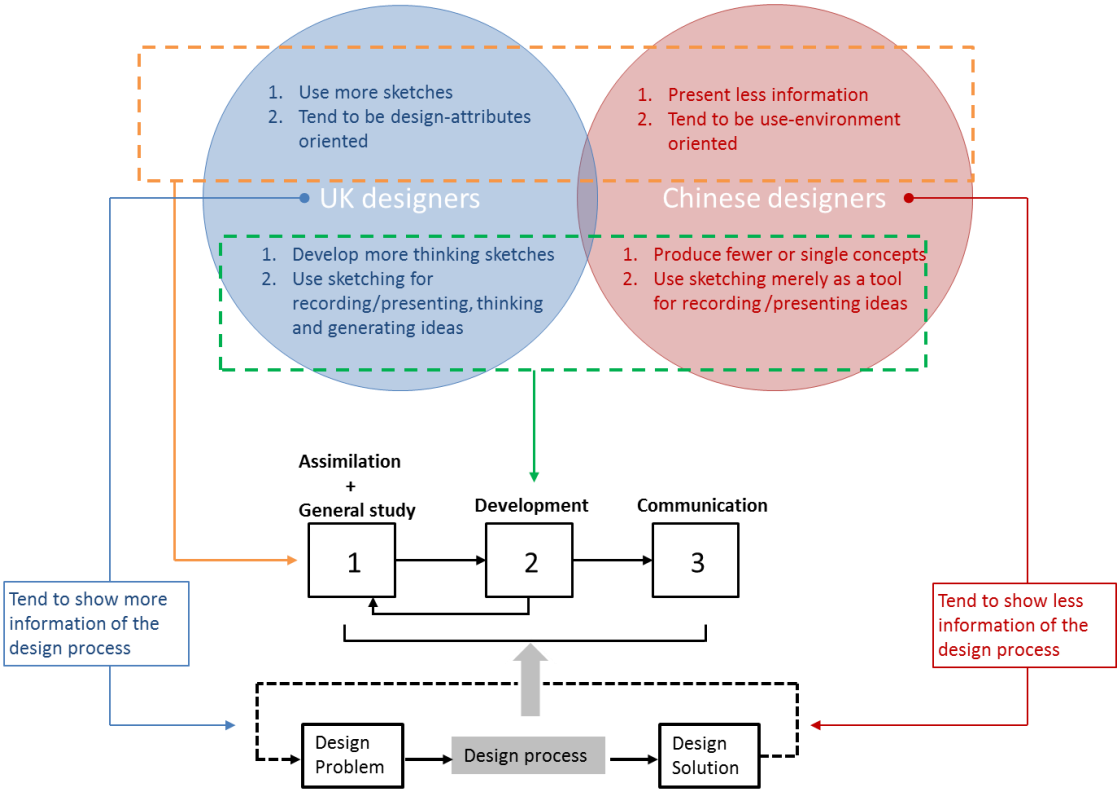


Figure 7.16 Differences found in design process between the UK and Chinese professional designers

7.5.1 The different ways of perceiving sketches

7.5.2 The differences in ways of defining the design problem

7.5.2.1 Primitive vs. Environment

The results shown in Table 7.6, which is about the categories of the inputs, namely the texts, sketches or keywords of online research, indicate the different ways the two groups of designers define the design problem. In general, from the

sketch sheets, the UK designers tended to focused more on the **primitives** of the design, such as the aspects of aesthetics, ergonomics and functionality. The Chinese designers paid more attention to the **environment** in which the design would be used. The Chinese designers' focus on the aspect of localization in the element of **requirements** could also be related to emphasis on the environmental element, as it was closely related to the local city, which is one the aspects of **environment** in this task. This result agrees with the result of semantic word cloud analysis on the design submissions from Study 3, which showed that the Chinese student designers focused more on the context of use environment of the product, which were garden and home respectively for each project. They also tended to get inspiration from the perspective of the environment. In the present study, the Chinese designers also showed the same tendency. As shown in Figure 7.17, designer CN10 targeted the design of the condiment counter for a Starbucks located in Gu Lou, a famous building in Ningbo City with distinctive vintage Chinese style. The main concept of CN10 was focused on the Chinese style. Designer CN6 designed a Starbucks with the elements of containers at the beginning of his design and developed his design mainly from the element of containers. Designer CN7 assumed his design was used by a Starbucks located in Tian Yi Square and took the element of the shape of a building in the Tian Yi square to formulate his design.

The result in the participants' experience with Starbucks (section 7.4.3.4) excludes the possibility that that the familiarity level of Starbucks might influence the route of information search. Actually, potential reasons for the differences in the focuses identified during the design process can be found in the theories of the mode of thought. Many academics have noticed the differences in the Western and Chinese style of cognition: namely the analytic vs. holistic mode of thought. Westerners tend to see parts and pay more attention to the focal object, whereas Chinese tended to see the whole, which also means that they pay more attention to the elements in the field and also attend more to the field (Nisbett et al. 2001; Chiu 1972; Ji et al. 2000; Choong & Salvendy 1999; Gelfand & Kashima 2015; Imai et al. 2016; Ishii 2013; Ji & Yap 2016). With an analytic mode

of thought, UK designers tended to understand how things as individuals or particulars that have properties (Chang 2012). They emphasise the object itself and its attributes, which in this case are the primitives of the design, namely the detailed attributes in aesthetics, functionality and ergonomics, etc. On the other hand, working with a holistic mode of thought, the Chinese designers tended to take the perceptual or conceptual field as a whole and focused on the relationship among the objects and the field, which in this case is the consideration of the environment in which the design would be used, either the direct one, namely the environment of the Starbucks in this case, or the more macroscopic one, namely the attribute of the local city.

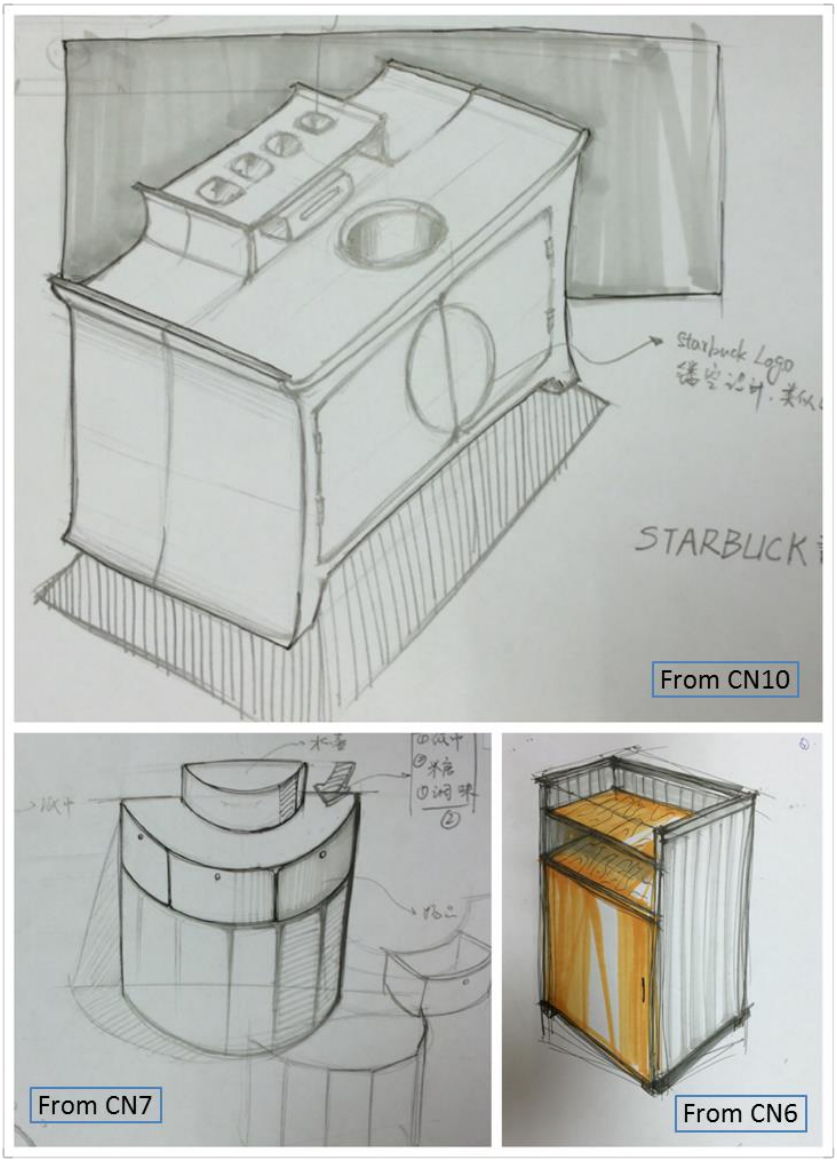


Figure 7.17 Examples of design ideas from Chinese designers

7.5.2.2 Differences in the representations

From the point of view of the forms used in the representations in Phase 1, the two groups also showed different characteristics. Noticeable differences could be found in the use of sketches and online searching.

Sketches

The UK designers tended to do more sketches than the Chinese designers. A large proportion of the sketches were about the layout of the inner space of the store, which also indicates why they tended not to draw on the given layout map. The Chinese did not do much sketching in this phase, instead they tended to draw on the layout map directly. This result also confirms the results of Study 3 which showed that the UK student designers tended to use more concrete elements such as sketches and pictures in Phase 1, which contradicts with the Chinese vs. Western - way of thinking from some other academics as they claimed that Chinese tended to use concrete items to formulate their cognitive process compared to the Westerns who tended to use analytic and abstract ways of thinking (Chiu, 1972; Lin, 1939; Northrop, 1946; Rau et al., 2004).

Online searching

Results in section 7.4.3.1 indicates that, compared to the UK designers, the Chinese designers spent much more time in searching online and also tended to look for inspiration online compared to the UK designers. Most of the Chinese designers got inspiration from the environment (Starbucks and local city) and existing products (condiment counter), which were also two of the main themes of their online searching (find in Table 7.6). Instead of writing or sketching the inspirations down on the sketch sheets, most of them applied the information directly to the design that was forming in their mind.

Although it was not statistically significant, the data also showed a tendency of the UK designers to use more texts in this phase than those from the Chinese designers. From the overall point of view, the sketch sheets from the UK designers showed statistically significantly more information compared to the

Chinese designers. According to the research of Chueng-Nainby (2010), who investigated the differences in the performance of Chinese and Western designers in a collaborative design environment in the early design stage, found the Chinese designers tended to keep silent during the design meetings. The kind of silence is to some extent similar to the lack of information that was presented in the sketches sheet in Phase 1 of the design process in this study. Chueng-Nainby (2010) found that the Chinese designers were discouraged to actively discuss when a higher authority was present and attribute the silence to the high power distance (Hofstede et al. 2010) of Chinese culture. Actually, this kind of silence, both verbally and in the sketch sheets, could also be attributed to Hall's (1989) high- and low- context cultural dimension as has been explained in section 6.5.1. In a high-context culture, Chinese people tended to express less than the conversation that actually took place in their mind, which when applied to the design activities, the designers present much less than the things that were in their minds. Another possible reason could be that the holistic way of thinking makes it difficult to put the thoughts into words, similar to the reason why think-aloud test is not suitable for Chinese people (Shi 2008; Clemmensen 2012).

7.5.3 Differences in developing the design

These differences were observed in two ways: firstly, the UK designers tended to develop more concepts and also more complex sketches; secondly, based on the observation of the design process and confirmed by statistical difference in the sketch types, the UK designers used sketches as both a tool for recording and presenting design thoughts and also as a tool for aiding thinking, whereas the Chinese designers tended to use sketches merely as a way of recording and presenting their design thoughts but rarely as a tool to aid them in generating design ideas. These two results also echoed the results from Study 3.

Descriptions of the some of the designers' specific design processes could help to address the differences in a more vivid way.

7.5.3.1 Typical Chinese design process

Most of the Chinese designers only developed one concept (CN1, 3, 4, 5, 6, 7 and 9) and the typical procedure can be presented as follows using the process from participant CN5 (Figure 7.18):

After analysing the customer flow in the shop and the items that were needed to be placed on the condiment counter, CN5 searched the inner space of Starbucks and pictures of condiment counters. He found a design that he thought was quite good. With the consideration of safety, he improved some small details such as the surface area for placing water pots and drew it as Sketch 1. He then considered changing the top part to make more space to place items and drew Sketch 2. In Sketch 3, he changed the top part of the design, which is also different from Sketch 2. He also changed slightly the design of the lower part to make it easier to put in the bin. In his final design (Sketch 4) he increased the height of the top layer and also drew a top view (Sketch 5) to indicate the left part should be smaller than the right part with the consideration of the customer flow in the shop. It is clear that he didn't sketch some of the in-between steps that happened in his mind, such as the change of the top part from Sketch 2 to Sketch 3 and the change of the bottom part from Sketch 1 to Sketch 3.

Another typical characteristic of the Chinese design process could be indicated by the process from participant CN8 (Figure 7.19). He was one of the few Chinese designers who developed more than one concepts (three concepts, which is also the highest in the Chinese designers). The way he developed the process was as follows: His initial idea was about the reduction on the size of one cabinet to create a relatively appealing style, but he found it quite boring so gave up quickly after two sketches of this concept. Then he came up with the idea of a table, which was inspired by the idea of making the ground of the area easier to clean and he drew a level 2 sketch of this idea (sketch 1). After this he was inspired by the idea of a modular system then quickly drew a level 2 sketch of this idea (sketch 2). Then he started with the presentation board plan of the table concept (sketch 3) and then the plan of the modular system idea (sketch 4). After this, he continued with the final design of the table idea and also a front view (sketches 5

& 6). Then he repeated the final steps again in the concept of a modular system 9 (sketch 7 & 8). Figure 7.10 shows the 'well planned' design steps of his process. It is easy to see that when he was designing, he had all the ideas clear in his mind before he started to draw them out. He used the sketches mainly as a tool for recording ideas in his mind, which also confirmed in the interview.

7.5.3.2 Typical UK design process

The UK designers tended to use the sketches as a tool for "helping to generate ideas" much more than the Chinese designers. Take part of the design process from the designer UK1 as an example (Figure 7.20): in his third sketch sheet, UK1 was working on the surface shape of his first concept, after drawing 7 different types of surface shapes in top view (sketch 1-7), he thought "Oh, I can do this!" and then jumped to the second concept (sketch 8-9). He then came back to do another sketch of the surface shape of concept 1 (sketch 10) and came up with the third concept of adding a wall on the left side to separate the toilet from the condiment counter, for which he drew two sub-concepts (sketch 11-12 & sketch 13-14). The procedure of UK 01 indicated that at this stage, his ideas were greatly influenced by the sketches. In other words, he was using the thinking sketches rather than the prescriptive sketches at that stage.

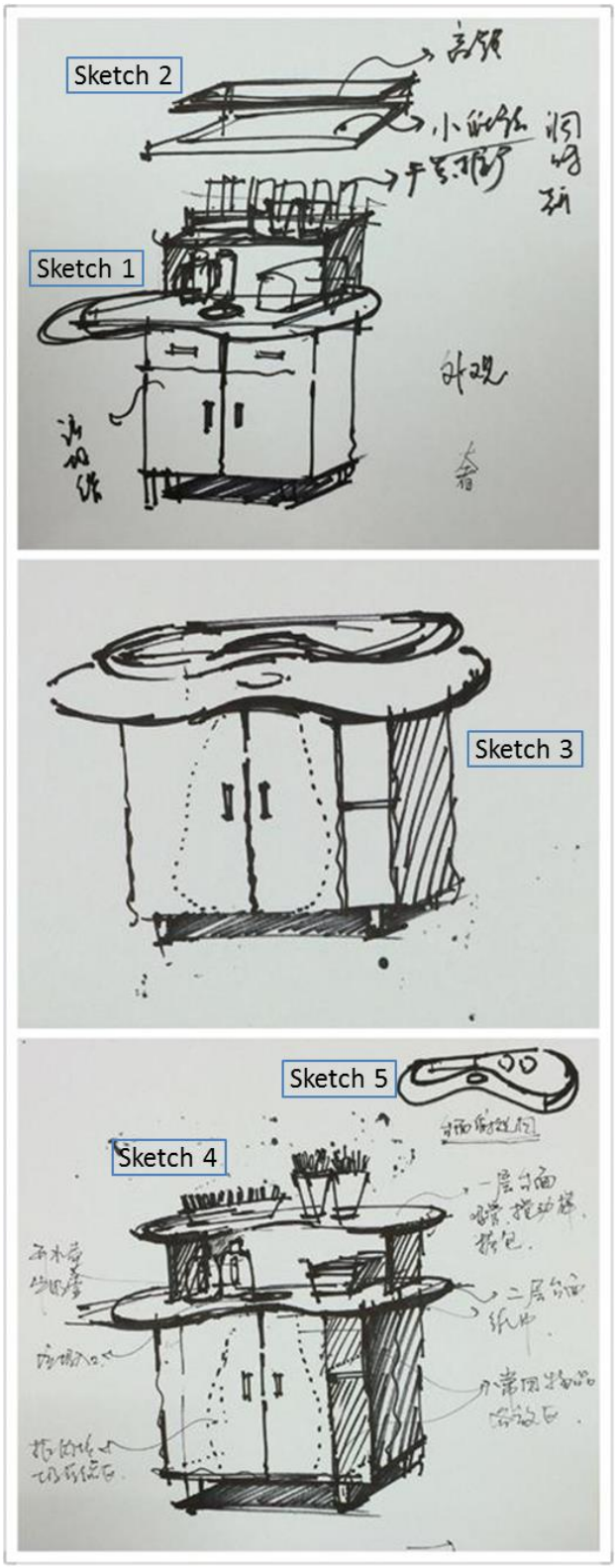


Figure 7.18 Design process of Chinese designer CN5

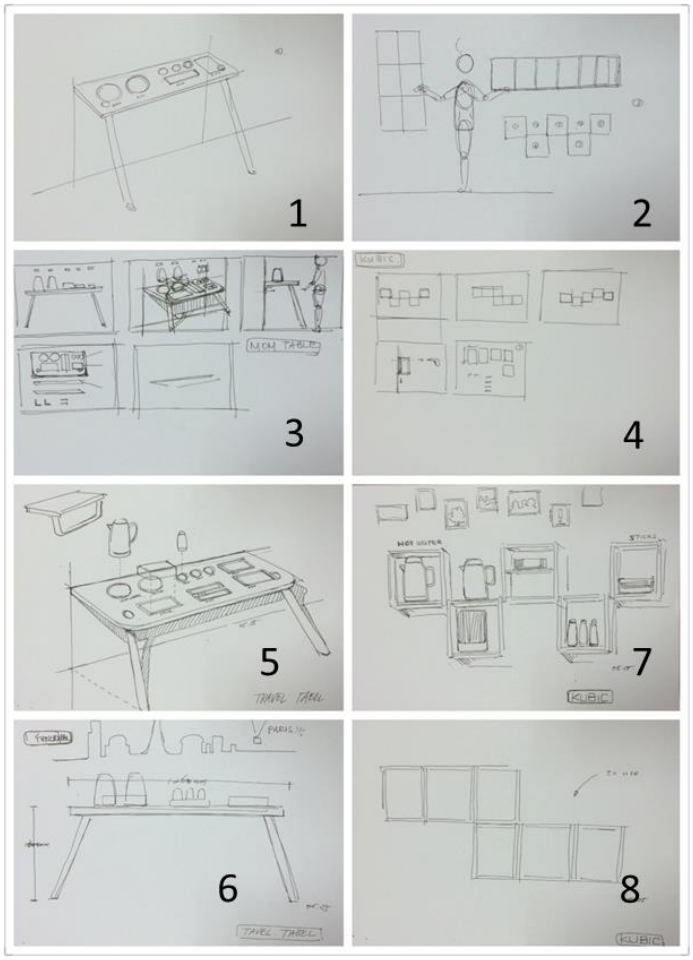


Figure 7.19 Part of the design process from CN8

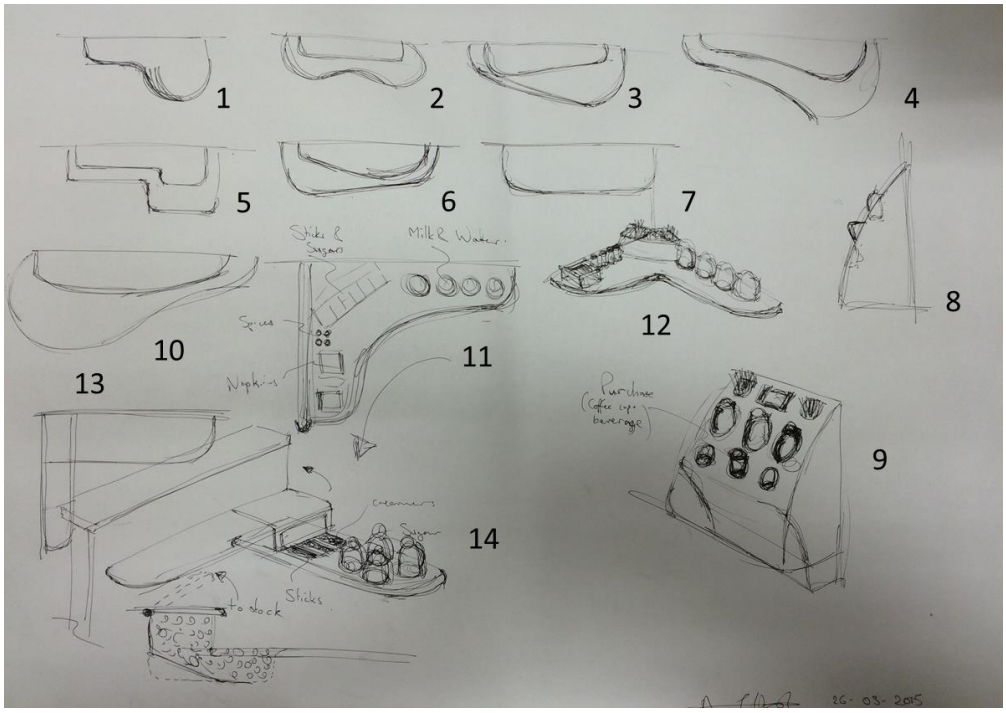


Figure 7.20 Part of the design process from UK1

7.5.3.3 Some conclusions from the interview

The UK designers tended to draw more and use the sketching as a tool for inspiring thinking compared to the Chinese designers. This kind of phenomenon was also confirmed by the interviews with the UK designers. When designer UK2 was talking about one of his sketches, he said "I don't like that either, but it's good to record it because at least you don't forget it". UK4 said that he "can't think without drawing" and UK6 also said drawing helped him to think more efficiently. On the other hand, Chinese designers tended not to present much of the things that appeared in their minds, especially when they had no direct use for the design. For example, designer CN6 mentioned that his initial idea was to design something that was more of a Chinese style, but then he found the modern style was more suitable for the Starbucks environment. He picked the second idea eventually without any sketches or indication about the initial idea that came to his mind.

The simplified design processes of the Chinese designers seem to echo with their consistent performance during the whole design activity. The same reasons from the cultural dimensions and different cognitive styles could also be applied to explain the differences shown here. The interview with the designers revealed another possible reason for the "simplified" design style. Participant CN5 told the researcher that when he was doing the design course in school, the requirement of the course work did not give much value to the design process but tended to focused on the final design. This kind of school education experience could have a great influence on the formulation of the Chinese designers' simplified design process.

7.5.3.4 The influence of school education

The changes of the '2+2' students on their design representations indicated the possible influence of school education on their design behaviour. This result was also confirmed in this study. From the statistical test, it could be noticed that the data from participant CN8 (No.18 in the SPSS output) always acted as an outlier (Figure 7.8, 7.9, 7.11). CN8 was one special case among the Chinese designers, as

he had received two years' undergraduate course in Product Design in a Chinese university and also four years' undergraduate course in a German university. He had also spent about two years' internship experience in some German design studios. His design behaviour was influenced quite a lot by the Western style of design. The expression of this kind of influence was the more sketches and concepts in his design process compared to the other Chinese designers, which also agrees with the situation that happened on the '2+2' students in Study 3, who tended to develop similar amount of sketches as their UK colleagues in Project 4. Chueng-Nainby (2010) in her research mentioned the differences in the design education in the UK and China from the point of view of some of her participants. The participants in her research, who had educational experience in both the UK and China, concluded that UK design education values more on personality and the identity of the individual student and the students also enjoy more freedom; whereas the Chinese design education tended to be more instructional with the emphasis on techniques and students learning through imitation. The differences in the education could influence the design behaviour considerably. However, as also indicated in Study 3, influence from the school education and maybe also from the peers around, seemed to only affect the numbers of sketches and concepts, rather than on the way student designers used sketches. The presenting of the design process of CN8 above reveals a clear tendency of developing the idea before sketching it and sketches were only used as a tool for presenting ideas. Another Chinese designer CN6 also had taken a two years' master course in the UK, but his design process did not show obvious differences from other Chinese designers, with only one concept and a few more sketches (11). Most of the Chinese designers tended to show an obvious attribution in their design behaviour, which could be defined as a retrospective way of sketching, namely having the idea in mind first and then manifesting it with sketch. These phenomena indicate that the cultural influence on the design behaviour is much stronger than other factors such as school education.

7.5.3.5 The influence of work experience

In Section 7.3.1, the demographic data from the participants showed that the UK designers had more design experience compared to the Chinese counterparts. As introduced in Section 2.2.6, it was not until the 1990s that product design education started to prevail in China; therefore the product designers are relevantly younger there. The work experience is normally closely related to the expertise. In his research, Cross (2004) compared expert and novice designers and identified some attributes of expert designers. He found that expert designers tended to be solution-focused, not problem-focused. They were found to be proactive in problem framing, actively structuring and formulating the problem and directing solution searching. Furthermore, most expert designers tended to be readily attached to single, early solution concepts rather than generating a wide range of alternative solution concepts. Interestingly, the attributes of the expert designers seem to really fit to the design behaviour of the Chinese designers, rather than the more experienced UK designers. Although within the UK designers, these descriptions seem to meet the reality: Participant UK6, who got the most experience among the UK designers (36 years), was also one of only three participants who only generated one design concept with 4 sketches. To some extent, the attributes in expert designers really fits to the Chinese way of design. Further studies could be conducted from this perspective.

7.5.4 Validity of the study

The aim of this PhD research was to investigate the cultural differences in the design as a process from the design problem to design solution, therefore this study only addressed the early stage of the design process that starts from the design task and ends in the generation of possible design solutions. In a real design project, a complete design process involves many more steps such as communication with team members and clients, field trip, user investigation, CAD modelling, modelling, etc., but this was out of the scope of this research. On the other hand, this study also attempted to validate to the greater extent, the differences found in student designers by the use of design practitioners. In the interviews, the designers were asked to what extent had they found their design

process in this study to represent to their normal design activities, and most of them confirmed there to be very similar (Table 7.9). The missed parts normally referred to the time limit, communications (with team members or clients), field trips, etc. But most of them confirmed that the process from the design problem to the design solution was very close to their normal design activities. Additionally, as a task was restricted to in 1.5 hours, most of them were satisfied with their performance.

7.6 Conclusion

This study was conducted to investigate the differences in Phase 1 (Assimilation + general study) and 2 (Development) of the design process with professional UK and Chinese designers and also to validate the findings from the former study which involved student designers. The results showed that there were obvious differences in the two Phases, which also confirmed the former findings. In Phase 1, the differences were found in the forms of representation of the design problem and also in the content of interpretation the design problem. The Chinese designers tended to do more online searching, but represented less information in the sketch sheets. The UK designers tended to sketch more compared to the Chinese designers. The UK designers focused more on the primitives of the design whilst the Chinese designers focused more on the environment of using the product. In Phase 2, the UK designers tended to develop more concepts and also more complex sketches. They also showed a clear tendency to develop more thinking sketches compared to the Chinese designers. There were obvious relationships between the concepts from the UK designers compared to the Chinese designers. In general, compared to the processes of UK designers, the Chinese design process tended to be a simplified version. A large amount of the implicit cognitive process was not presented tangibly in the design representations. School education was found to have an influence on the formulation of the representations, but did not affect the retrospective way of sketching of the Chinese designers. Another interesting finding is that the attributes of the Chinese designers' design behaviour seem to

fit to the attributes of experienced designers. Future work could be conducted to explore this further.

8 DISCUSSION AND CONCLUSION

8.1 Chapter overview

The key findings from the research are discussed in this chapter, with reference to the literature review of the relationship between design and culture. The potential explanations from the cultural perspective are discussed. The recommendations for design practice and original contributions to the knowledge area are also presented. Suggestions for future research are made, and the limitations of the research are highlighted.

8.2 Introduction

The overall aim of this research was to investigate the cultural differences in product design in the UK and China. It firstly explored the concepts of design and culture, and also the relationship between the two concepts to establish a background understanding to inform the research carried out, which was the Objective 1 as shown in Table 8.1. It mainly explored the differences in product design from two perspectives: 1) design outcome, namely the role of culture in the design outcomes from UK and Chinese designers, in which the differences in the evaluation of UK and Chinese general users were particularly discussed, which was Objective 2 as shown in Table 8.1 below; and 2) the design process, namely the role of culture in the design process from UK and Chinese designers, which was Objective 3 as shown in Table 8.1. Four studies were conducted to investigate the cultural differences from the two perspectives. Table 8.1 summarises the set-ups, the methods used and the main results in each study.

Table 8.1 Summary of the four studies of this research

Objective 1	**To develop a background understanding of the concepts of design and culture and also the relationship between the two concepts**	
Literature review	Explore the literature on the concepts of design and culture, and also on the relationship between the two concepts.	
General methodology	Explore the methodological approach in the area of studying product design in a cross-cultural context and from the perspective of design outcome and design process respectively.	
Objective 2	**To Investigate the cultural differences in product design from the perspective of design outcome**	
Study	Study 1: Probing cultural differences from the design outcomes	Study 2: Validating the results from Study 1 in the evaluation of design outcomes and explore in further detail
Method	Interview using Repertory Grids	Online questionnaire
Objects	18 pieces of design work (9 from UK students and 9 from Chinese students)	3 types of popular products in the UK and Chinese market
Participants	UK: 15: 10 general public + 5 qualified designers	UK general public: 65
	CN: 15: 10 general public + 5 qualified designers	CN general public: 128
Results	1. Differences in the design features: UK designs - rounded shapes, simple structures, fewer functions and less creativity; Chinese designs - squarer shapes, complex structures, more added functions and greater creativity	Differences in design evaluation: UK participants: aesthetics (colour, shape, styling & decoration) > ergonomics (ease & comfort of use, safety of use) > creativity (in appearance & usage)
	2. Differences in design evaluation: UK participants: aesthetics > usability > creativity; Chinese participants: usability > aesthetics > functionality + creativity	Chinese participants: aesthetics (styling & decoration, material) = ergonomics (ease & comfort of use, safety of use) = creativity (in appearance)
Objective 3	**To investigate the cultural differences in product design from the perspective of design process.**	
Study	Study 3: Probing cultural differences in design process with student designers	Study 4: Probing cultural differences in design process with design practitioners
Method	Ethnographic observation + reflection analysis on the design submissions + semantic word cloud analysis	Protocol study + interview +coding analysis
Participants	UK students: 11	UK designers: 10
	'2+2' Chinese students: 6	Chinese designers: 10
	Ningbo Chinese students: 6	

Results	In design patterns: 1. Chinese students tended to consider the design task in a relational-contextual way; 2. Chinese students tended to focus more on the use environment; 3. UK students tended to use more sketches and pictures in Phase 1 whereas the Chinese students used more textual material. In design cognition: Chinese students tended to produce less sketches; Chinese students tended to use sketching as a tool for recording of presenting ideas rather than aiding thinking.	In design patterns (in Phase 1): 1.UK designers used more sketches; 2. Chinese designers presented less information in their representation; 3. UK designers tended to focus on design primitives, whereas Chinese designers tended to focused on the environment aspects. In design cognition (in Phase 2): 1.UK designers tended to develop more concepts and generate more thinking sketches. 2. Chinese designers tended to produce single design concept and use sketching merely as a way of recording and presenting ideas.

8.3 Overview of literature review for the relationship between design and culture

The focus of the literature review was to understand the relationship between design and culture. As Cross (2013) pointed out, design knowledge resides firstly in people, not only designers, but also in every individual. Due to the different people it refers to, Cross also concluded that design research is mainly conducted from two perspectives: design process – which investigates the design activity from the point of view of designers, namely how people design, and how design methodology is used to aid the design process; and design outcome – the forms and materials and finishes which embodies design attributes. The relationship between design and culture in this research was also explored from these two perspectives.

From the perspective of design outcome, its relationship with culture was revealed by the “onion” model from Hofstede et al. (2010), which divides the concept of culture into four layers: symbols, heroes, rituals, and values (Figure 2.8, Section 2.4). The pattern and symbols contained in a culture are inevitably maintained in their artefacts (Kroeber and Kluckhohn, 1952 cited by Razzaghi et al., 2009). Also, with the development of the concept of user centred design, the relationship between user and design has a great influence on the attributes of design outcome. Product acceptance and user satisfaction is not only derived

from the provided functionality and usability, but also from the interaction, experiences and pleasurability (Jordan 2000), which could be facilitated greatly by the integration of cultural considerations. The literature review has found the influence of culture on design outcomes, among which a big part was in the area of Human Computer (Marcus & Gould 2000; Snelders et al. 2011; Marcus 2003; Evers & Day 1997) and also in a small number of research projects in specific product design area such as car design (Bluntzer et al. 2014) and cellular phone design (Seva & Helander 2009). Culture was found to have an influence on the design attributes and also the user's preferences of specific design attributes. There is some research that explored the cultural influence on design from the perspective of the Chinese users (Choong & Salvendy, 1998; Evers & Day, 1997; Marcus, 2003; Shen et al., 2006), but most of them focused on interface design rather than product design. There still remains a paucity of literature that addresses the cultural aspects of product design outcome from the perspective of Chinese culture. This research explored the cultural differences in the UK and Chinese design outcomes, with an emphasis on the differences in the evaluation of UK and Chinese general users.

The role of culture in the design process can be traced to the theories of design cognition. Purcell & Gero (1998) described design as one of the significant intellectual activities because of its complexity and the effects its results have on society. This kind of complexity is enhanced due to the influence of culture on the way a designer structures a design concept (Razzaghi & Ramirez 2009). Although it is limited, there is some research that explored the role of culture from the perspective of the design process (Choe 2004; Moalosi 2007; Chueng-Nainby 2010). Chueng-Nainby's (2010) research confirmed that there are differences in design behaviour between Western and Chinese designers from the perspective of concept negotiation in collaborative design. The literature review also revealed a gap in the research that addresses the cultural differences from the perspectives of the explicit cultural patterns and the implicit cognitive processes in the design practice. In the development of design methodology, design has been interpreted from two different perspectives, namely

prescriptivism and descriptivism. The former takes design as a rational problem solving practice whereas the latter takes design as a reflective practice. Both of these two theories have value in understanding design activities, therefore in these research models both models from prescriptivism and descriptivism were applied to interpret design behaviours in an explorative and holistic way.

8.4 Summary of research findings

8.4.1 Differences in the design outcome

The role of culture in the design outcome in this research was investigated from two dimensions: 1. How culture is maintained in the design outcome, namely the cultural differences in the features of design outcome; 2. How culture affects the general users' evaluation of design outcome.

In Study 1, from the interpretation of the UK and Chinese participants, the differences in the features in the designs of a stationery rack from the UK and Chinese designs were revealed: the UK designs tended to have rounded shapes, simple structures, fewer functions and less creativity, whereas the Chinese designs tended to have squarer shapes, more complex structures, more added functions and also showed greater creativity. Also, the study found that there were differences in the criteria of the evaluation of design outcomes used by the UK and Chinese participants, as both tended to value more the designs from the designer with the same cultural background. For the UK general public group, they put aesthetics as the most important criterion, followed by usability and then creativity; whereas their Chinese counterparts took usability as the most important criterion, and then aesthetics, followed by functionality + creativity. In this study, the designer groups were designed as control groups, they both tended to focused more on the aesthetics. The UK designers had usability and creativity and design style in second place, whereas the Chinese designers focused more on the skills of drawing / presentation and had usability at the third place.

Study 2 was set to validate the results in the differences of evaluation of design outcome and also to explore it in further detail. In general, it found that UK people tended to pay more attention to the aesthetics aspect, whereas Chinese people tended to put relatively moderate weighting on all the three aspects. Two equations that predict the UK and Chinese people's online evaluation on a product were also generated based on the findings, which are listed as follows:

UK:

Predict judgement = constant x + a_1 x **colour + a_2** x **styling & decoration + a_3** x **shape + b1** x **ease & comfort of use + b_2** x **safety + c_1** x **material + c_2** x **creativity in usage + c_3** x **creativity in appearance**

Note. ***|a| > |b| > |c|***

CN:

Predict judgement = constant x + a_1 x **styling & decoration + a_2** x **material + a_3** x **ease & comfort of use + a_4** x **creativity in appearance + b_1** x **colour + b_2** x **shape + b_3** x **safety of use**

Note. ***|a| > |b|***

Figure 8.1 Predict equations of the UK / Chinese way of online design evaluation

Based on the finding of Study 1 and the literature review, a model of online design evaluation was developed and the findings of the differences between the UK and Chinese participants were manifested in the model (Figure 8.2-8.3). The findings validated parts of the results of Study 1: 1) they validated that there were significant differences in the criteria of design evaluation between the UK and the Chinese groups; 2) they agreed that the UK general public take the aesthetics as the most important criterion, and usability and creativity the second and third respectively; 3) the results from the Chinese participants were slightly different from Study 1, in which aesthetics and ergonomics tended to be equally valued, with slightly more emphasis on the aesthetics rather than focused more on the ergonomics aspect. The finding also addressed the criteria in the

aspects of aesthetics, perceived ergonomics (usability, functionality) and creativity to a more detailed level, based on the products used for evaluation: the aspect of aesthetics was explored from: colour, shape, styling & decoration and material; the aspect of perceived ergonomics was explored from: ease & comfort of use, safety of use and size & weight; the aspect of creativity was explored from: the creativity in appearance and usage respectively. Study 2 explored the differences in the evaluation of general product design between the UK and Chinese general public in a detailed way and filled the relevant vacancy in design studies.

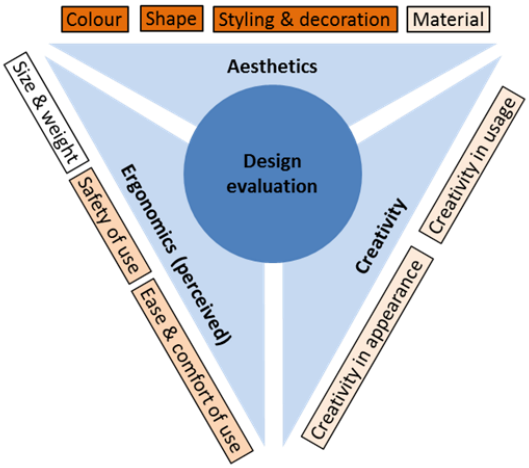


Figure 8.2 Aspects of importance identified in the UK online design evaluation [9]

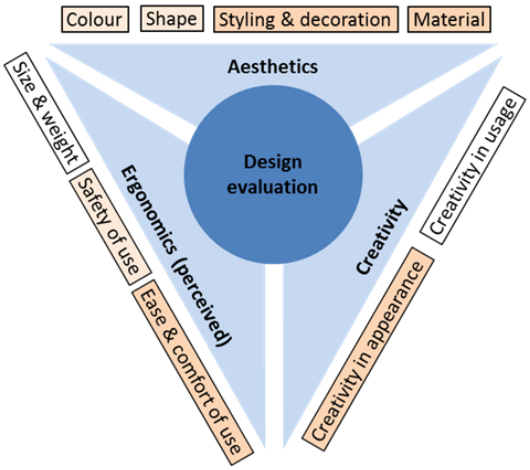


Figure 8.3 Aspects of importance identified in the Chinese online design evaluation

[9] The deeper the colour, the greater the influence from the specific element on the overall evaluation.

8.4.2 Differences in design process

The cultural differences in the design process in this research were investigated from the perspectives of the explicit cultural patterns and the implicit cognitive processes in the design practice. The former here refers to the contents that are presented in the design representations and the latter refers to the invisible thinking processes based on which the design processes were structured.

In Study 3, which was conducted with design students, the differences found in the **design patterns** showed that the Chinese student designers tended to consider the design task in a relational-contextual way, i.e. they tended to consider the relationships between different themes. Such as in the Garden Lighting project, they interpreted the project from the perspectives of "garden" and "lighting" separately, as for them the "garden" was also an important topic. The same things happened in their interpretation of the design attributes such as "material" & "manufacture", "aesthetics" & "material". Another feature of the Chinese designers was that they tended to pay great attention to the use environment, i.e. the "garden" in Project 1 and "home" in Project 4. The UK designers tended to pay great attention to make their design simple, which echoes with the results of Study 1 that the UK designs tended to have simple structures. Another notable difference existed in the format of representation in Phase 1 between the two groups. According to the design submissions, the UK students tended to use more sketches and pictures, whereas the Chinese students tended to use more textual material.

In the perspective of **design cognition**, in the beginning of Study 3, i.e. in Project 1, the CN and '2+2' groups had very close performance in terms of coding numbers in Phase 2, which was much less than the UK counterparts. This phenomenon changed a lot when it came to Project 4. Instead of being similar to CN groups, the performance of the '2+2' group was close to the UK group in terms of the coding numbers, i.e. the numbers of coding of the two groups were much higher than that of the CN group. The finding indicates that the Chinese student designers tended to produce less sketches compared to the UK

counterparts. The number of sketches during the design process could be significantly influenced by other factors such as school educations and peer influence. Nevertheless, given the similar performance in the number of sketches, the findings of the ethnographic observation suggested that there were distinctive ways in using sketching between the UK and Chinese student designers. The Chinese students kept their way of using sketching in a retrospective way, and only as a tool of recording and presenting ideas rather than helping generating ideas. The differences found in design students were also presented in the research model as shown in Figure 8.4.

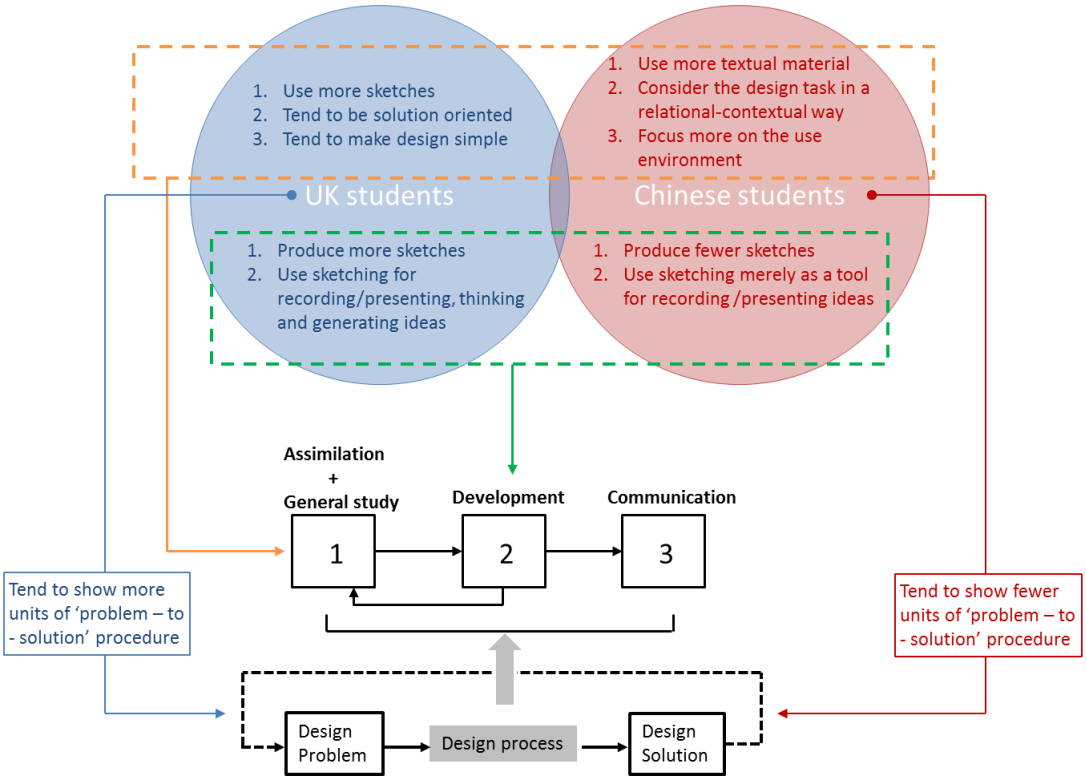


Figure 8.4 Differences found in design process between the UK and Chinese design students

Study 4 confirmed the results in Study 3, through the protocol study with the design practitioners. From the finding in **design patterns** showed in Phase 1, the UK designers tended to use more sketches, which was confirmed with the result in Study 3 that the UK students tended to use more sketches and pictures at this stage of the design process. The Chinese designers tended to present less information in their design representation compared to the UK designers. Also,

the two groups had differences in defining the design problem: the Chinese designers tended to pay great attention to the environment aspect, which agrees with the result of Study 3; the UK designers focused more on the design primitives, i.e. attributes such as aesthetics, ergonomics and functionality. The differences in **design cognition**, which were mainly found in Phase 2, confirmed the results of Study 3 that the UK designers tended to develop more concepts and also generate more thinking sketches. They tended to use sketches both as a means of recording and presenting, and generating ideas. On the other hand, most (7/10) of the Chinese designers tended to produced only one concept and a large amount of the implicit cognitive process was not presented tangibly in the design representations. They tended to merely use sketching as a way of recording and presenting ideas. In general, the design process of the Chinese designers tended to be more "simplified" compared to the UK counterparts. The differences found in design students were also presented in the research model as shown in Figure 8.5.

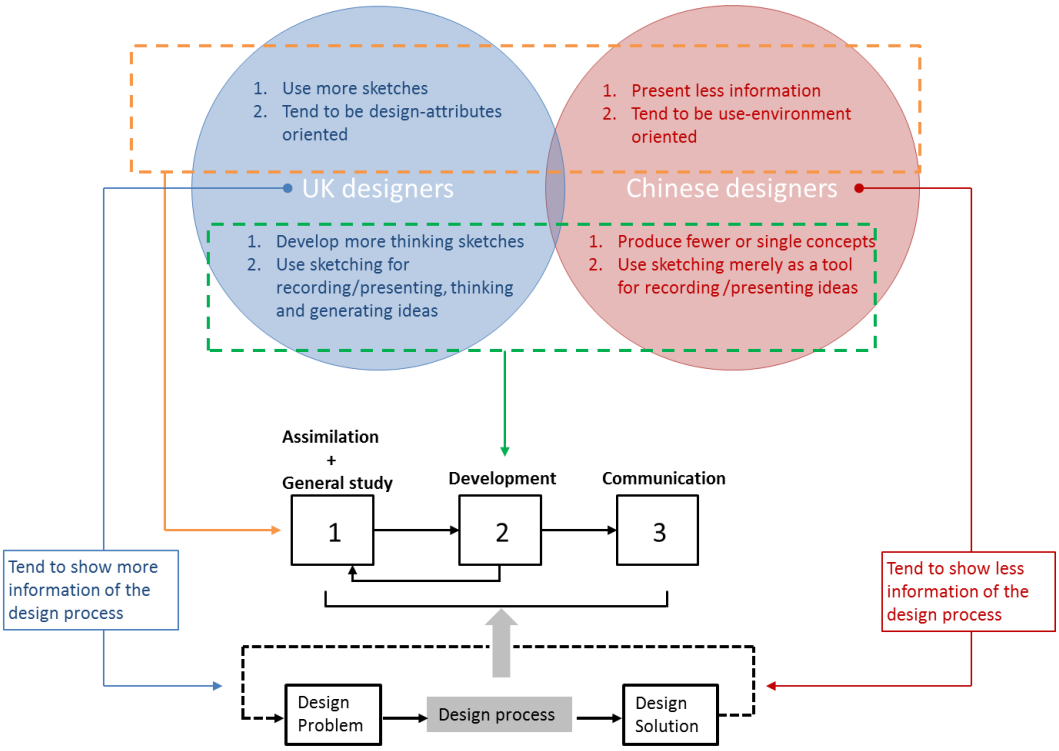


Figure 8.5 Differences found in design process between the UK and Chinese professional designers

Study 3 and 4 were for the first time in design studies that explored the cultural differences in design patterns and design cognition between designers from two different cultures. The identified differences in UK and Chinese design processes also suggested new ways of interpreting design activities and may kindle potential future studies.

8.5 The role of culture in the differences

From the differences in the UK and Chinese society from the perspective of cultural dimensions introduced in Section 2.3.3, it was expected that there would be detectable differences in product design of these two countries. China is a collective and restrained society with high power distance, long-term orientation and a high context environment; whereas the UK, on the other hand, is an individual and indulgent society with low power distance, short-term orientation and a low context environment. These particular attributes of the two societies breed two unique styles of product design, in both the perspective of design outcome and design process.

8.5.1 Culture and design outcome

The findings on the differences in design outcome revealed pictures of attributes of designs from the UK and Chinese students in a quite distinctive way: UK designs – **rounded shapes**, **simple structures**, **fewer functions** and **less creativity**; Chinese designs – **squarer shapes**, **complex structures**, **more functions** and **greater creativity**. The underlying reasons for these differences could be traced to the cultural differences.

The **Indulgence vs. Restraint** is a dimension that refers to the nature of subjective well-being. As a society with a high Indulgence index, the UK people are supposed to allow free gratification of basic and natural desires and enjoy life and have fun. The society is supposed to be loose, with a higher percentage of happy people who tend to have a positive attitude, and value leisure. On the other hand, the Chinese society, as a typical restraint culture, was expected to curb natural desires and have strict social norms. Chinese people tend not to

value leisure in the relatively tight society. The lines and shapes that appeared in the students' designs to some extent reflect this type of difference. According to the paper *The Affective Tone of Lines* from Lundholm (1921), curve lines with long and low waves always stands for slow and weak movement, whereas lines By referring this interpretation back to the attributes showed in the designs, the findings echoes with the indulgence and restraint attributes of the society respectively. Hofstede et. al, (2010) also mentions the attributes of "thrift" in the dimension of Indulgence, according to which the restraint societies are supposed to value thrift as an important moral. This could be another explanation for the squarer shapes applied in the Chinese designs, as they are supposed to be good at saving space when displayed on a desk and also easy to fit into a space.

Also, the different evaluation on "thrift" indicates the possible explanation of the **simplicity** vs. **complexity** features in the UK and Chinese designs. By checking the designs it is easy to find that a large proportion of the UK designs tended to be a simple "pot" as a pen holder, whereas the Chinese designs tend to have different components for different types of stationery so as to make full use of it and prevent any possible waste. The "simplicity" attributes in the UK designs also echoed with the findings of Study 3, in which the UK general public tended to value heavily on the ease & comfort of use in the aspect of perceived ergonomics. Additionally it was also confirmed in the results of the semantic word cloud analysis in Study 3, where the UK designers tended to pay much more intention to the simplicity attribute of their design compared to their Chinese counterparts (Section 6.5.3). The **Time orientation dimension** may also suggest some of the deeper reasons for this kind of phenomenon. According to Hofstede et al. (2010), China is a typical nation with long-term orientation as a consequence of the long history of the teachings of Confucius. The long-term society tends towards "thrift, being sparing with resources", rather than "social pressure toward spending"; pursuing long-term profit rather than focus on short-term interests. Therefore in terms of design, the designers tend to think rather more than just focus on the essential functions of the product.

The **dimension of high and low-context** from Hall (1989) also suggests some explanation to the **simplicity** vs. **complexity** features in the designs. According to Hall, in the high-context cultures, the outside environment is found to be much more important than the inside settings. High-context communication has been identified as being indirect, ambiguous, maintaining harmony, reserved, and understated (Gudykunst et al. 1996). Chinese people tend to communicate in a high-context way, which relies highly on the information that is maintained in the environment. Therefore, the designs, which are a significant part of the daily environment, tend to be complex so as to deliver more information than they orally expressed. On the contrary, UK people are in a low-context system, in which low levels of programmed information are used to provide context. The interpersonal communications are largely dependent on the information to be direct/explicit, precise, dramatic, open, and are based on feelings or true intentions (Gudykunst et al. 1996). Correspondingly, their physical environment tends to be simple and carrying less information.

As Hosftede et al. (2010) indicated in their book, although various studies have been conducted to investigate people's preference among alternatives, the answers elicited from them should not be taken too literally, because it could be that the way people act in reality does not coordinate with the answer they provided on the questionnaire. However, the use of Repertory Grid in Study 1 had successfully revealed the distinct differences that exist in the design work from an individual's idiosyncratic view. The following studies also confirmed some of the attributes such as the **simplicity** vs. **complexity**. All these in general delivered useful information of an unneglectable influence from culture on the design outcomes. Although Hofstede (2006) suggested that his cultural dimensions are highly abstract and far above the respondents' daily concerns, the indexes on the dimensions of the UK and Chinese societies provide good criteria of interpreting the differences from the perspective of culture.

8.5.2 Culture and design process

Cultural differences also have a great influence on the way people think (Nisbett et al. 2001). Since the design process is the thinking process of the designer solving design problems, the differences shown between the UK and Chinese designers are also closely related to the differences in the cognitive system. Section 2.3.4 has introduced some of the main findings in the cognition between UK (Western) and Chinese people.

By tracing back to the Ancient Greeks and Chinese civilization, which gave rise to European and post-Columbian American civilization and Chinese civilization respectively, there was already obvious evidence of **Analytic** vs. **Holistic** cognition from the respect side (Nisbett et al. 2001). The analytic mode of thought tends to pay attention to parts and focal object and interpret things predominantly in terms of traits; whereas the holistic mode tends to see wholes and the relationship among elements in the field, they interpret things through contextual factors and pay more attention to the environment (Nisbett et al. 2001; Ji et al. 2000). An obvious manifestation of this cognitive difference is in the differences in the pattern of primitives-focused vs. environment-focused in the UK and Chinese design processes. The environment-focused attribute of the Chinese designers were found both in the submissions of design students and also the work from design practitioners. Compared to the UK counterparts, they tended to pay lots of attention to use environment of the design, which in Study 3 was the “garden” and “home” theme, in Project 4 the “local city” and “Starbucks” in Phase 1. The UK designers in Study 4, on the other hand, showed outstanding tendency of focusing on the aesthetics, ergonomics and functionality aspects of the design primitives.

An interesting finding in differences in patterns of design process was in Phase 1, the UK designers tended to use more sketches (also pictures in Study 3), whereas the Chinese designers tended to use more textual material. According to the theory of Analytic vs. Holistic cognition modes, the Chinese cognitive style is supposed to be “synthetic, concrete, and remain on the periphery of the visible

world", whereas the Western style is "analytic, abstract, and imaginative or beyond the realm of the immediately apprehended" (Chiu 1972; Choong & Salvendy 1999). The findings in this research, however, contradicted this theory, in which the UK designers tended to use more concrete materials and Chinese designers used more abstract materials.

The **Analytic vs. Holistic** cognitive style also suggested some underlying reasons for the "simplified" style of Chinese design process compared to their UK counterparts. Shi (2008) suggested in his study that the Chinese holistic thinking style make them difficult to verbalize in the higher levels of thinking. The same interpretation could be applied to the Chinese style of design process. As they tended to think of the design process in a holistic way, the Chinese designers tended to formulate processes from design problem to design solution in their mind first and then presented them in sketches. Compared to the analytic style, which tends to construct the design process step by step and analytically, the design representation of the Chinese designers tend to be briefer, and left out lots of the underlying cognitive activities that actually took place when they generated the solutions. Also, the UK designers who developed the process in an analytic way needed sketching as a tool for aiding thinking; whereas for the Chinese designers it's more a tool for presenting and recording the pre-existing ideas. This kind of difference also agrees with the **Monochronic time** (M-time) vs. **Polychronic** time (P-time) attributes of the UK and Chinese cognitive style (Hall 1989). The M-time cognitive style indicates that the UK designers tend to focus on one thing at a time. In the case of design, they tended to deal with one sketch at a time and move on to the solution step by step. On the other hand, with the P-time cognitive style, the Chinese designers tended to deal with several ideas at the same time and make decisions quickly in their mind and finally only presented the ones that they chose in the design representations.

Hall's (1989) cultural dimension of high and low-context, to some extent, also suggests some explanation of this phenomenon. As a typical high-context society, the Chinese style of communication is assumed to be indirect, ambiguous, maintaining of harmony, reserved, and understated (Gudykunst et al. 1996).

When applied to the design activities, the Chinese designers tended to present much less than the things that are in their minds. On the contrary, the UK people are used to communicating in a way that is direct/explicit, precise, dramatic, open, and based on feelings or true intentions (Gudykunst et al. 1996). Therefore, the UK students tended to naturally present things that were going on in the mind. One thing worthy of mention here is that, less information presented in the design representations does not necessarily mean that the actual design cognitions of the Chinese designers were much simpler than the UK counterparts. It merely indicated that the Chinese design cognition is more implicit and difficult to capture.

8.6 Recommendations for design practice

The findings of the research presented in this thesis also suggests valuable information in guiding design practice that takes place in the UK / China design markets.

The differences from the perspective of design outcome between the two cultures indicate the necessity to consider different attributes maintained in the products when designing for the relevant market. According to Forlizzi (2008), in the field of interaction design, most user-product interaction focused on the interaction between one user and one product. There is still paucity of knowledge about the interaction between products and groups of people and the relevant social behaviour following the interaction. Study 1 and 2 in this research investigated this kind of interaction and confirmed the cultural differences in the relevant interaction between the UK and Chinese people. These kinds of differences will inevitably give rise to different social behaviour, in which product acceptance is one of the most affected aspects. As Cross (2013) claimed, everyday design work usually entails the attributes of precedents or previous exemplars, the different attributes of designs from the UK and Chinese student designers found in Study 1 also revealed the differences that existed in the everyday crafts in the long history of the two cultures. The differences in design attributes led to the differences in the design acceptance along the history of

these two cultures, which was confirmed by the differences in the evaluation of design outcome found in Study 1 and 2. The long history of the two cultures has formulated their respective characteristics in the appreciation of products, which plays a vital role in the acceptance of design in contemporary society. The findings from Study 2 (Figure 8.2 – 8.3) revealed the different appreciation regarding the aspects of aesthetics, perceived ergonomics and creativity, which also indicate that different emphases on the design attributes should be taken when designing for the relevant market. It showed that for the UK market, the colour, shape, styling and decoration of the appearance of products are the most important elements that need to be considered, together with the consideration of the safety, ease and comfort of use. Whereas on the other hand, for the Chinese market, a balance of all the three aspects needs to be considered, with some special emphases on the styling and decoration, material used of the appearance, the ease and comfort of use and the creativity in appearance.

The differences from the perspective of the design process between the two cultures offers valuable suggestions in areas such as design education and collaborative design practice in a multi-cultural environment, which were typical of today's product industry.

The findings in Study 3 and 4 show that compared to the UK designers, the Chinese designers, either design students or professional designers, tended to use sketching merely as a way of recording/presenting design ideas, rather than aiding thinking and idea generation; they were also found to show much less information of their cognitive design process. These differences reveal the implications for understanding the role of culture in approach to design process, which also present the potential improvement in design education, especially for the China part (Figure 8.6). The differences could be attributed to the cognitive differences between the people from the two groups, as has been discussed in the previous sections; also, as has also been confirmed in the two empirical studies that, school education plays an important role in the designers' performance, especially in the way they developed the design representations. Section 2.2.3 briefly reviews the history of product design education in the UK

and in China. In the history of design education, the two countries have formed their own distinct characteristics. The UK design education tends to encourage students to develop more representations that stand for the actual cognitive process during design activity, which also encourages the student to use sketching as a tool for generating ideas. Compared to their UK counterpart,

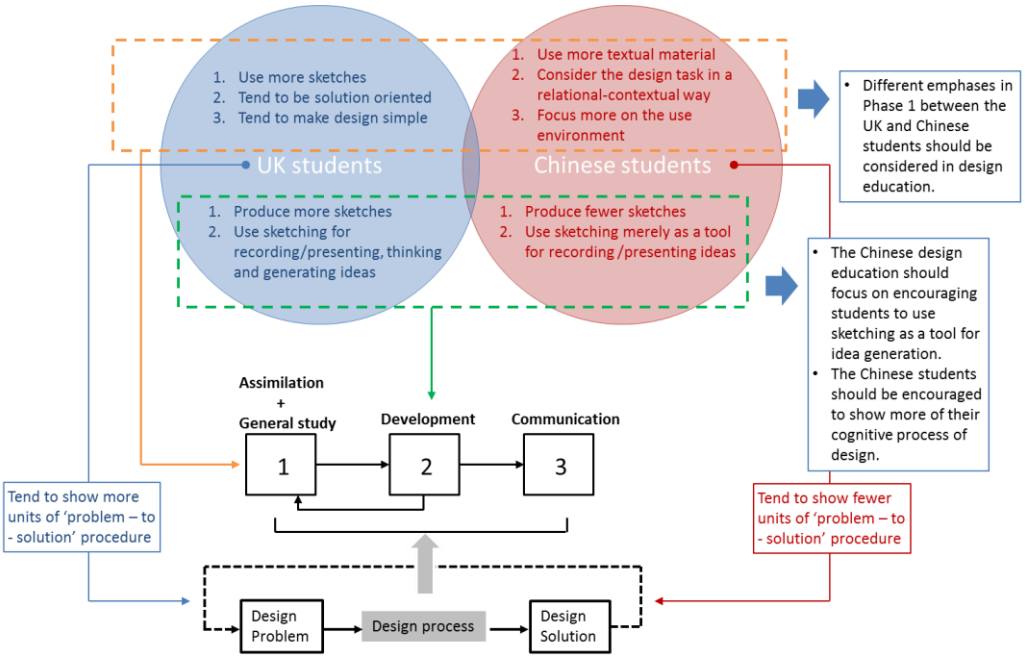


Figure 8.6 Recommendations of application of the findings (design students) in design education

design education in China was initiated later and is relatively immature and still in the exploration mode through the influence of German, Japanese and Russian design education (Liu 2015; Yuan 2003; Shen & Zhang 2001). The Chinese design education tends to be more instructional with the emphasis on techniques and students learning through imitation (Chueng-Nainby 2010). It also tends to focus more on the design outcome rather than the design process, which results in the phenomenon that the Chinese designers tended to show less of their cognitive process and used sketching merely as a tool for recording and presenting ideas during the design process. The role of sketching in design has been discussed in section 2.2.4. Due to the nature of design activity, it is a repetitive process that loops between design problems and design solutions. Sketching as the basic element of design activity provides for the designer with a tool to translate descriptive propositional information into depiction and also performs as a

thinking and reasoning aid. Its role in constructing the design problem and aiding the generating of solutions has been declared by many researchers (Schön 1991; Cross 1990; Dorst & Reymen 2004). Cross (2004) claimed that expert designers also tended to be solution-focused, rather than problem-focused, due to their rich experience in formulating design solutions from framing design problems. However, at the stage of receiving design education, when the level of expertise is still "novice", a design student needs to follow strict rules to deal with the problem (Dorst & Reymen 2004). To encourage the student to use sketching as a tool for thinking and reasoning aid will help them to follow the rules to formulate a more structured thinking process. At the meanwhile, using sketching as a tool of thinking will also facilitate the students to show more of their cognitive design process, which will also help them regulate their design process. To encourage students to use sketching as a tool for aiding thinking and to show the cognitive design process should be taken as one of the main focuses of the development of Chinese design education. Also, for design education that is taking place in a multi-cultural environment, such as the Product Design courses in the University of Nottingham, the revealed cognitive differences between UK and Chinese students and its influence on design cognition provided valuable information in dealing with students from different cultural backgrounds. The comparison between design submissions from '2+2' and Ningbo Chinese students demonstrated that the way of presenting the design process could be greatly influenced by school education and other factors such as peer influence. Proper guidance based on these findings from students with different cultural background would lead to better student performances. Further study is needed to explore design education from the perspective of the student's cultural background.

The findings of the different design cognition between the UK and Chinese designers also offered valuable information in the collaborative design practice among designers from different cultures, which is nowadays a trend of design industry. As shown in Figure 8.7, differences were found in Phase 1 - the Chinese designers tended to be use-environment oriented whereas the UK designers

tended to be design-attributes oriented. This finding suggests that when the designers are accumulating and searching information related to the design problem, UK and Chinese designers would tend to have different emphases on the investigation of the design problem. This kind of difference could be applied to a design project (such as in a team brain storm) to actually get a better grasp of the project. The cognitive difference between the UK and Chinese designers make them see different parts of the design problem. An integration of these different views of the design problem would push the investigation more thoroughly. Also, the differences found in Phase 2 - Chinese designers tend to show less of their cognitive process where UK designers tended to use sketching as a tool for thinking, suggest a more flexible management of the design group to fit with the different cognitive styles of the designers. In the stage when designers are developing and refining design solutions, a more flexible environment would make the team work more efficiently. This approach was also suggested by Chueng-nainby (2010), who claimed that Chinese designers tended to ideate whereas western designers tended to conceptualise and she suggested a more flexible design practice to solve this type of dichotomy between the designers.

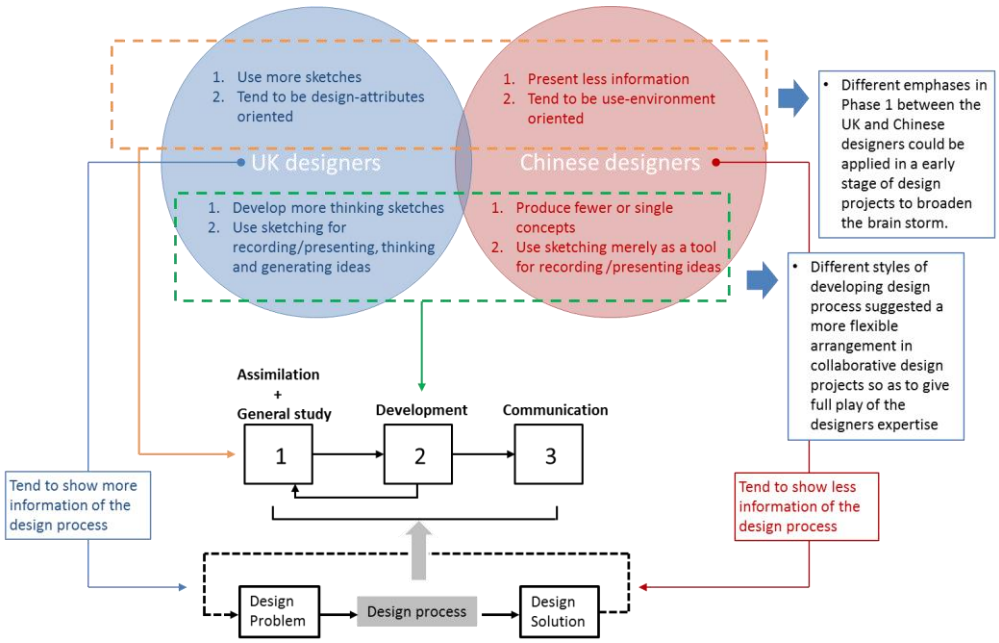


Figure 8.7 Recommendations of application of the findings (design practitioners) in collaborative designs

8.7 Contribution to knowledge

From the overall point of view, the main contribution of this research was to give a comprehensive view of the role of culture in product design that takes place in the UK and China. It explored the cultural influence from the perspective of design outcome and design process between the UK and Chinese product design and addressed the paucity of literature in the relevant area.

Additionally, it also proposed some new research methods that could be applied to design studies, especially in a cross-cultural context, which are listed as follows:

- **Investigate cultural differences in the attributes of design outcome using Repertory grids analysis**

Repertory grids (RG) as a tool developed by Kelly (1955) is a technique that promises accurate measurement of subtle perceptions (Easterby-Smith 1981) and in the meanwhile minimises the biases from the researcher. However, given the promising future of RG, it is still "little used beyond its specialist adherents" (Jankowicz 2003), especially in the area of design studies. In the area of design, a well-defined problem is vital to the development of a successful design solution (Lai et al. 2010). Based on the theories of user centred design, the key to a well-defined problem is the efficient interactions with users. The application of repertory grid technique would help the researchers explore deeper the users interpretation of any specific area and therefore could ultimately enhance the design. Study 1 proposed a subjective approach to investigate the cultural differences in design outcomes that are developed at an individual level, using repertory grids as a basic technique. The adoption of repertory grid technique offered a semi-structure to the interview and therefore also solved the dilemma of whether structured or open-ended questions should be adopted as the main body of the interview process (Day & Evers 1999; Vatrapu & Perez-Quinones 2004). It helps to make the process more controllable, but not imposing any predetermined destination characteristics from the researchers which are not relevant to the interviewees (Hankinson 2006). Furthermore, the method of

content analysis of repertory grids that combines both core-categorisation and Honey's content analysis also solved the limitations of the application of repertory grids proposed by Hassenzahl & Wessler (2000) (Section 4.6.1).

- **Online design evaluation model**

Based on the findings in Study 1 and also the relevant literature review, a design model was proposed in Study 2 for online evaluation of products in the aspects of aesthetics, perceived ergonomics (usability, functionality) and creativity (see in Figure 5.1). To evaluate design in the format of pictures, i.e. from the perspective of visual appearance, is a totally different story compared to design evaluation in the format of design entity; however it is still a commonly used method, which could also be applied in situations such as online shopping or design evaluation at the conceptual stage. The evaluation model deals with three main aspects and also the detailed attributes under each aspect, i.e. aesthetics - colour, shape, styling & decoration and material; perceived ergonomics - size & weight, safety of use, and eases & comfort of use; and creativity – in appearance and in usage. It also suggests a correlation between the evaluation on the three aspects and their detailed attributes and the overall design evaluation, which was explored in Study 2 with the UK and Chinese general public.

- **Post-hoc reflective analysis for investigating the design process of student's design submission**

Study 3 proposed a design research model that combined the reflective design model of "problem-to-solution" to the adjusted three phases of design procedure from the RIBA Architectural Practice and Management Handbook (1965, cited by Lawson 2006) (see in Figure 6.5). This model is a combination of descriptivism and prescriptivism design paradigms and therefore integrates the advantages of the two design paradigms. The descriptive part of the model meets the ground theory of defining design as a process deduced from the design problem to the design solution. As Gero & Mc Neill (1998) described it, the conceptual design process is "the designer navigating through an abstract

problem domain and employing various strategies to elaborate the problem description". This interpretation made it possible to study design submissions from the design students in the post-hoc way, given the miss of data on the actual design process. The prescriptive part of the model, i.e. the defined phases of the design process, decomposes the design process in a logical way and makes it possible to reveal the reasons behind the designers' actions at different stages. Study 3 also developed a coding system to categorise the information in the design submissions into problem and solution units which, with the supplementary of the division of three phases, visualised the potential process the specific designer had gone through in their way of formulating the design task. The encoding of the problem-to-solution process also revealed the potential cognition process maintained in the design submission and made it possible to compare the cognitive process from different designers. According to the findings with this research model, UK and Chinese students showed notable differences: in Phase 1, they tended to use different form of material to show their ways of constructing the design problems and were found to have different emphases then defining the design problem; in Phase 2, important differences were found in their ways of using sketching and also in the amount of 'problem-to-solution' units, which represents their cognitive processes. The finding were also validated with the design practitioners, the two groups of designers had different focuses in Phase 1 and showed significant difference in the number of concepts generated and also in the way of using sketching in Phase 2. These differences, together with the research model on which they were generated, have furthered the knowledge in the cultural differences between UK and Chinese designers in their design approach.

8.8 Limitations of the research

There are a numbers of limitations of the research undertaken in this thesis. These are outlined below:

As an exploratory study, Study 1 was set to examine possible differences in the design outcomes. It also took the professional background as a variable to

investigate the possible influence, which made the study complicated. At the analysis stage, although it was clear that there were differences between the evaluation of qualified designers and the general public, it was not explored in detail as it was out of the scope of this research (Section 4.6.3). Future study could be conducted to explore the role of professional background in design evaluation.

Regarding the criteria used in Study 2 of design evaluation, it focused on the three aspects of aesthetics, perceived ergonomics and creativity, which were based on the findings in Study 1. Although according to the literature, these three aspects were also the commonly mentioned criteria when applied in design evaluation, there could be other aspects that are important in design evaluation but not covered in Study 1. The limit of three aspects may not be sufficient to apply to an evaluation of other types of product.

The design practitioners recruited in Study 4 was not high in the diversity of samples. For the UK part, the designers were mainly recruited in Nottingham and for China, most of them were recruited in Ningbo. This limitation in the recruitment areas could make samples not as representative as to stand for the whole nation's product design status. The differences were found to be quite distinctive between the two cultures. A more variable sample may reveal more differences in the design cognition between the UK and Chinese designers.

8.9 Suggestions for future research

The outcomes of the research highlight the differences both in the perspectives of design outcome and design process in product design between the UK and China. Nevertheless, the topic is quite a broad one and there are numbers of detailed areas that are worthy of investigation:

- The differences in the evaluation criteria of the design outcome were narrowed down to the specific items from the aspects of aesthetic, perceived ergonomics and creativity (Section 5.4.2). The results in Study 1 and 2 both suggested that the evaluation on these detailed aspects greatly influenced

the overall evaluation. Therefore it would be useful to detect further how the UK and Chinese people actually evaluate these detailed aspects. For example, the result of Study 2 shows that both the UK and Chinese general public take the "styling & decoration" as one of the most items from the aspect of aesthetics, but their overall evaluation differentiated from each other in the product type of kettles and bathroom scales. What would be their criteria for judging a design to be good or bad at "styling & decoration"? Such information would be useful in designing particular products that face a particular market.

- As mentioned in the research limitation, this research did not address the design evaluation from the designer's perspective. The little bit of the result of Study 1 which compared the criteria of UK and Chinese designers in design evaluation showed that there were potential differences. Future studies could be conducted to explore it in further detail, which would also be useful to understand the design behaviours of the designers from the two cultures.
- The 'simplified' attributes of the Chinese design process were found to be similar with the descriptions of the expert designer's design behaviour from Cross (2004). It would be interesting to look in detail the cognition process of these two set of designers to explore similarities. Also, as mentioned before, the 'simplified' Chinese design process was only defined from the perspective of design representations. The Chinese designers tended to 'hide' their actual cognitive activities. Protocol analysis is a widely used tool for investigating design cognitions but also widely criticised (Lloyd et al. 1995) and some researcher have suggested that it was not appropriate for Chinese culture (Shi 2008; Clemmensen et al. 2009). It is therefore suggested to explore more potential methods to elicit the cognition activity of Chinese designers, which would then contribute towards a better understanding of the cultural differences in design cognition.

8.10 Conclusion

The research presented in this thesis aimed to investigate the role of culture in product design taking place in the UK and China. Its objects involved design

outcomes such as student design work, existing products; and designers, both student designers who were still receiving design education and experienced design practitioners who worked for design institutions either in the UK or China. Also design process was either from the design submissions of students, or real-time design tasks in protocol studies. Based on the theories of design methodology, the research explored, in an empirical way, product design activities in these two cultures from the perspectives of design outcome and design process.

From the perspective of design outcome, this research applied the technique of repertory grids analysis to investigate the differences on the attributes of designs from the UK and Chinese students and also the design evaluation from UK and Chinese people. The findings confirmed the influence of culture in design outcomes. Designs from the UK and Chinese student designers were found to have distinctive attributes. The designs from the UK students tended to have rounded shapes, simple structures, fewer functions and less creativity; whereas the designs from the Chinese student designers tended to have squarer shapes, more complex structures, more functions and greater creativity. Also the evaluation of design from the UK and Chinese people were found to differentiate from each other. They were found to have different emphases on the aspects of aesthetics, ergonomics and creativity. UK people tended to put more weighting on aesthetics when evaluating designs, compared to their Chinese counterparts. A further study applied an online survey to validate the differences in design evaluation and also explored the differences in the aspects of aesthetics, ergonomics and creativity at a more detailed level.

From the perspective of design process, two empirical studies were conducted to investigate the design activities of designers from the two cultures. As a compromise to ethical consideration, a post-hoc reflective method study was conducted to the analysis of design submissions from UK and Chinese students, supplemented with an ethnographic observation of daily design activities in a studio. A method of semantic word cloud analysis was also applied to the

submissions to explore the different ways the participants formulated their design project. Differences were found in the patterns of design process as well as in the design cognitions presented in the design representations. UK students were found to sketch more and used sketching as a means of recording, presenting and generating ideas, whereas Chinese students tended to sketch less and used sketching more as a tool for recording and presenting ideas. A further protocol study with design practitioners from the two cultures was conducted to explore the differences in a more direct and detailed way. The participants were asked to design a condiment stand and also explain their design process in a retrospective interview after the design task. Differences in the design pattern and design cognition found with student designers were validated with the design practitioners. In general, the designers were found to have different ways of constructing their design task. They had different a focus when formulating the design problem: the UK designers tended to focus on design attributes, whereas the Chinese designers focused more on the use environment. They also showed different design cognition during the process: the UK designers tended to show more information about their thoughts, sketched more and developed more concepts, whereas the Chinese designers tended not to present their cognitive process, sketched less and focused on a single concept. The Chinese design process turned out to be more simplified compared to the UK counterparts.

Deep-rooted reasons for the revealed differences were discussed by referring to cultural models from researchers such as Hofstede et al. (2010) and Hall (1989) and Studies on the cognition differences between Chinese and Western people (Ji & Yap 2016; Imai et al. 2016; Ishii 2013; Gelfand & Kashima 2015). Recommendations were also made for the application of the findings in this research to different areas of the design industry, such as design practice in the relevant markets, design education, design collaboration in a multi-cultural environment.

REFERENCES

Abras, C., Maloney-Krichmar, D. & Preece, J., 2004. User-centered design. *Bainbridge, W. Encyclopedia of Human-Computer Interaction. Thousand Oaks: Sage Publications*, 37(4), pp.445–56.

Ajiferuke, M. & Boddewyn, J., 1970. "Culture" And Other Explanatory Variables In Comparative Management Studies. *Academy of Management Journal*, 13(2), pp.153–163.

Akin, Ö., 1986. *Psychology of architectural design*, London: Pion limited.

De Angeli, A., Sutcliffe, A. & Hartmann, J., 2006. Interaction, usability and aesthetics: What influences users' preferences? *Proceedings of the 6th Conference on Designing Interactive Systems*, (November), pp.271–280.

Arhippainen, L. & Tähti, M., 2003. Empirical evaluation of user experience in two adaptive mobile application prototypes. *Proceedings of the 2nd international conference on mobile and ubiquitous multimedia*, pp.27–34.

Atkinson, P. & Hammersley, M., 1994. Ethnography and Participant Observation. *Handbook of Qualitative Research*, 1(23), pp.248–261.

Barth, L., Kobourov, S. & Pupyrev, S., 2014. Experimental Comparison of Semantic Word Clouds. *13th International Symposium, SEA 2014*, pp.237–258.

Baskerville, R.F., 2003. Hofstede never studied culture. *Accounting, Organizations and Society*, 28(1), pp.1–14.

Bearden, W.O., Money, R.B. & Nevins, J.L., 2006. A Measure of Long-Term Orientation: Development and Validation. *Journal of the Academy of Marketing Science*, 34(3), pp.456–467.

Benedict, R., 1947. *The Chrysanthemum and the Sword: Patterns of Japanese Culture.*, London: Secker & Warburg.

Bilda, Z., Gero, J.S. & Purcell, T., 2006. To sketch or not to sketch? That is the question. *Design Studies*, 27(5), pp.587–613.

Blijlevens, J., Creusen, M.E.H. & Schoormans, J.P.L., 2009. How consumers perceive product appearance: The identification of three product appearance attributes. *International Journal of Design*, 3(3), pp.27–35.

Bloch, P.H., 1995. Seeking the Ideal Form: Product Design and Consumer Response. *Journal of Marketing*, 59(3), pp.16–29.

Bluedorn, A.C., Felker Kaufman, C. & Lane, P.M., 1992. How many things do you like to do at once? An introduction to monochronic and polychronic time. *Executive*, 6(4), pp.17–26.

Bluntzer, J.-B., Ostrosi, E. & Sagot, J.-C., 2014. Styling of cars: Is there a relationship between the style of cars and culture identity of a specific country? *Journal of Autombile Engineering*.

Bock, R.D. & Jones, L. V., 1968. *The measurement and prediction of judgment and choice*, San Francisco: Holden-Day.

Van Boeijen, A. & Stappers, P.J., 2012. Designers coping with culture in an educational setting. , (July 2011), pp.1–4.

Bohm, D., 2005. *Wholeness and the implicate order*, London and New York: Routledge.

Bond, M.H., 1991. *Beyond the Chinese face: Insights from psychology*, Hong Kong: Oxford University Press.

Braun, V. & Clarke, V., 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(May 2015), pp.77–101.

Brett, J.M., Tinsley, C.H., Janssens, M., Barsness, Z.I., et al., 1997. New approaches to the study of culture in industrial organizational psychol-ogy. In *New perspectives on international industrial organizational psychology*. San Francisco Cumulus: New Lexington Press.

Byoungho, J., Park, J.Y. & Sanruy, J., 2010. Comparison of Chinese and Indian consumers' evaluative criteria when selecting denim jeans. *Journal of Fashion Marketing and Management*, 14(1), pp.180–194.

Caldwell, N. & Coshall, J., 2002. Measuring brand associations for museums and galleries using repertory grid analysis. *Management Decision*, 40(4), pp.383–392.

Carbon, C.C. & Leder, H., 2007. Design evaluation: From typical problems to state-of-the-art solutions. *Marketing Review St. Gallen (Thexis)*, 2007(2), pp.33–37.

Chandrasekaran, B., 1990. Design Problem Solving : A Task Analysis. *AI Magazine*, 11(4), pp.59–71.

Chang, C., 2012. How people tell an ad story: Western vs. Asian styles. *Asian Journal of Communication*, 22(3), pp.235–252.

Chattalas, M., Kramer, T. & Takada, H., 2008. The impact of national stereotypes on the country of origin effect A. *International Journal of Logistics Management*, 25(1), pp.54–74.

Chiu, L.-H., 1972. A Cross-Cultural Comparison of Cognitive Styles in Chinese and American Children. *International Journal of Psychology*, 7(4), pp.235–242.

Choe, J., 2004. The consideration of cultural differences in the design of information systems. *Information & Management*, 41(5), pp.669–684.

Choong, Y.-Y. & Salvendy, G., 1998. Design of icons for use by Chinese in mainland China. *Interacting with Computers*, 9(4), pp.417–430.

Choong, Y.-Y. & Salvendy, G., 1999. Implications for Design of Computer Interfaces for Chinese Users in Mainland China. *International Journal of Human-Computer Interaction*, 11(1), pp.29–46.

Chueng-Nainby, P., 2010. *Conceptualisation, or not? An Ethnographic Study in Describing Early Design Collaboration between Western Designers and Chinese Designers*. Thesis, (PhD). Edinburgh Napier University.

CINIC, 2015. Statistical Report on Internet Development in China. Available at: http://www1.cnnic.cn/IDR/ReportDownloads/201507/P020150720486421654597.pdf [Accessed February 2, 2016].

Clemmensen, T., 2012. Usability problem identification in culturally diverse settings. *Information Systems Journal*, 22(2), pp.151–175.

Clemmensen, T., Hertzum, M., Hornbæk, K., Shi, Q., et al., 2009. Cultural cognition in usability evaluation. *Interacting with Computers*, 21(3), pp.212–220.

Clemmensen, T., Shi, Q., Kumar, J., Li, H., et al., 2007. Cultural usability tests - How usability tests are not the same all over the world. *Usability and Internationalization, Pt 1, Proceedings: HCI AND CULTURE*, 4559, pp.281–290.

Crilly, N., Moultrie, J. & Clarkson, P.J., 2004. Seeing things: Consumer response to

the visual domain in product design. *Design Studies*, 25(6), pp.547–577.
Cropley, A.J., 2000. Defining and measuring creativity: Are creativity tests worth using? *Roeper Review*, 23(2), pp.72–79.
Cropley, D.H. & Cropley, A.J., 2005. Engineering creativity: A systems concept of functional creativity. *Creativity across domains: Faces of the muse*, pp.169–185.
Cross, N., 2001. Design cognition: results from protocol and other empirical studies of design activity. In *Design Knowing and Learning: Cognition in Design Education*. Amsterdam: Elsevier, pp. 79–103.
Cross, N., 2013. Design Research : A Disciplined Conversation. *Design Issues*, 15(2), pp.5–10.
Cross, N., 1984. *Developments in design methodology*, New York: John Wiley & Sons.
Cross, N., 2004. Expertise in design: An overview. *Design Studies*, 25(5), pp.427–441.
Cross, N., 2007. Forty years of design research. *Design Studies*, 28(1), pp.1–4.
Cross, N., 1999. Natural intelligence in design. *Design Studies*, 20(1), pp.25–39.
Cross, N., 1990. The nature and nurture of design ability. *Design Studies*, 11(3), pp.127–140.
Cyr, D., Bonanni, C., Bowes, J. & Ilsever, J., 2005. Beyond trust: Website design preferences across cultures. *Journal of Global Information Management*, 13(4), pp.24–52.
Cyr, D., Head, M. & Ivanov, A., 2006. Design aesthetics leading to m-loyalty in mobile commerce. *Information & Management*, 43(8), pp.950–963.
Cyr, D., Head, M. & Larios, H., 2010. Colour appeal in website design within and across cultures: A multi-method evaluation. *International Journal of Human-Computer Studies*, 68(1-2), pp.1–21.
Day, D. & Evers, V., 1999. Questionnaire Development for Multicultural Data Collection. *International Workshop on Internationalsiation of Products and Systems*.
Day, D.L., 1996. Cultural Bases of Interface Acceptance: Methods. *AMCIS 1996 Proceedings*, p.Paper 104.
Deng, B. & Fan, S., 2013. Product designer: a study on the product design education (in Chinese). *Journal of Nanjing Arts Institute*.
Desmet, P. & Hekkert, P., 2007. Framework of product experience. *International Journal of Design*, 1(1), pp.57–66.
Dick, P. & Jankowicz, D., 2001. A social constructionist account of police culture and its influence on the representation and progression of female officers: A repertory grid analysis in a UK police force. *Policing: An International Journal of Police Strategies & Management*, 24(2), pp.181–199.
Dorst, 1997. *Describing design problems a comparison of paradigms*.
Dorst, K. & Cross, N., 2001. Creativity in the design process: Co-evolution of problem-solution. *Design Studies*, 22(5), pp.425–437.
Dorst, K. & Reymen, I., 2004. Levels of Expertise in Design Education. *International Engineering and Product Design Education Conference*, (September), pp.1–8.
Dowling, G.R. & Midgley, D.F., 1991. Using Rank Values as an Interval Scale.

Psychology and Marketing, 8(1), p.37.
Downey, S., Wentling, R.M., Wentling, T. & Wadsworth, A., 2005. The Relationship between National Culture and the Usability of an E-learning System. *Human Resource Development International*, 8(1), pp.47–64.
Dubberly, H., 2008. How do you design? Available at: http://www.dubberly.com/articles/how-do-you-design.html [Accessed March 22, 2014].
Easterby-Smith, M.P. V, 1981. The design, analysis and interpretation of repertory grids. *Internal Journal Man-Machine Studies*, pp.3–24.
Embacher, J. & Buttle, F., 1989. A Repertory Grid Analysis Of Austria's Image As A Summer Vacation Destination. *Journal of Travel Research*, 27(3), pp.3–7.
Everdingen, Y.M. Van & Waarts, E., 2003. the Effect of National Culture on adoption of innovations. , 14(3), pp.217–232.
Evers, V. & Day, D., 1997. The role of culture in interface acceptance. *Proceedings Human Computer Interaction, Interact'97*, (1993), pp.260–267.
Fallman, D. & Waterworth, J., 2005. Dealing with User Experience and Affective Evaluation in HCI Design : A Repertory Grid Approach. *Focus*, pp.2–7.
Fang, T., 2003. A Critique of Hofstede's Fifth National Culture Dimension. *International Journal of Cross Cultural Management*, 3(3), pp.347–368.
Fang, T., 2010. Asian management research needs more self-confidence: Reflection on Hofstede (2007) and beyond. *Asia Pacific Journal of Management*, 27(1), pp.155–170.
Field, A., 2013. *Discovering Statistics Using IBM SPSS statistics* 4th ed., London: SAGE Publications Ltd.
Fish, J. & Scrivener, S., 1990. Amplifying the Mind's Eye: Sketching and Visual Cognition. *Leonardo*, 23(1), pp.117–126. Available at: http://www.jstor.org/stable/1578475.
Fish, J. & Scrivener, S., 2014. Sketching and the Mind's Visual Eye: Cognition. , 23(1), pp.117–126.
Forlizzi, J., 2008. The product ecology: Understanding social product use and supporting design culture. *International Journal of Design*, 2(1), pp.11–20.
Fransella, F., 1977a. *A manual for repertory grid technique*, London: aCADEMIC pRESS.
Fransella, F., 1977b. The Measurement of Intrapersonal Space of Grid Technique (Book Review). *British journal of psychology*, 68(4), p.522.
Fryberg, S.A. & Markus, H.R., 2007. Cultural models of education in American Indian, Asian American and European American contexts. *Social Psychology of Education*, 10(2), pp.213–246.
Fulton Suri, J. & Marsh, M., 2000. Scenario building as an ergonomics method in consumer product design. *Applied Ergonomics*, 31(2), pp.151–157.
Gaver, B., Dunne, T. & Pacenti, E., 1999. Design: Cultural probes. *interactions*, 6(1), pp.21–29.
Geertz, C., 1973. *The interpretation of cultures*, New York: Basic books.
Gelfand, M.J. & Kashima, Y., 2015. Editorial overview: Culture: Advances in the science of culture and psychology. *Current Opinion in Psychology*, pp.1–7.
Gero, J.S. & Kannengiesser, U., 2004. The situated function-behaviour-structure framework. *Design Studies*, 25(4), pp.373–391.

Gero, J.S. & Mc Neill, T., 1998. An approach to the analysis of design protocols. *Design Studies*, 19(1), pp.21–61.

Gkouskos, D., Normark, C.J. & Lundgren, S., 2014. What Drivers Really Want: Investigating Dimensions in Automobile User Needs. *International Journal of Design*, 8(1), pp.59–71.

Gould, J.D. & Lewis, C., 1985. Designing for usability: key principles and what designers think. *Communication of the ACM*, 28(3), pp.300–311.

Griffin, A. & Hauser, J.R., 1993. The voice of the customer. *Marketing Scie*, 12(1).

Gudykunst, W.B., Ting-Toomey, S. & Tsukasa, N., 1996. Communication in Personal Relationships Across Cultures: An Introduction. In *Communication in Personal Relationships Across Cultures*. Sage.

Gulliksen, J., Göransson, B., Boivie, I., Blomkvist, S., et al., 2003. Key principles for user-centred systems design. *Behaviour & Information Technology*, 22(6), pp.397–409.

Hall, E.T., 1976. *Beyond culture*,

Hall, E.T., 1989. *Beyond Culture*, New York: Anchor.

Han, S.H., Hwan Yun, M., Kim, K.J. & Kwahk, J., 2000. Evaluation of product usability: Development and validation of usability dimensions and design elements based on empirical models. *International Journal of Industrial Ergonomics*, 26, pp.477–488.

Hankinson, G., 2006. Repertory grid analysis: an application to the measurement of destination images. *International Journal of Nonprofit and Voluntary Sector Marketing*, 9(2), pp.145–153.

Hansen, K.T., 2004. The World in Dress: Anthropological Perspectives on Clothing, Fashion, and Culture. *Annual Review of Anthropology*, 33(1), pp.369–392.

Hassenzahl, M. & Wessler, R., 2000. Capturing Design Space From a User Perspective: The Repertory Grid Technique Revisited. *International Journal of Human-Computer Interaction*, 12(3), pp.441–459.

Heimerl, F., Lohmann, S., Lange, S. & Ertl, T., 2014. Word cloud explorer: Text analytics based on word clouds. *Proceedings of the Annual Hawaii International Conference on System Sciences*, pp.1833–1842.

Heine, S.J., Lehman, D.R., Peng, K. & Greenholtz, J., 2002. What's wrong with cross-cultural comparisons of subjective Likert scales?: The reference-group effect. *Journal of personality and social psychology*, 82(6), pp.903–918.

Hekkert, P., 2006. Design aesthetics : principles of pleasure in design Design aesthetics : principles of pleasure in design. *Psychology Science*, 48, pp.157 – 172.

Herman, L., 1996. Towards effective usability evaluation in Asia: cross-cultural differences. *Proceedings Sixth Australian Conference on Computer-Human Interaction*, pp.135–136.

Hesse-Biber, S., Leavy, P., Quinn, C.E. & Zoino, J., 2006. The mass marketing of disordered eating and Eating Disorders: The social psychology of women, thinness and culture. *Women's Studies International Forum*, 29(2), pp.208–224.

Hofstede, G., 2001. *Culture's Consequences: Comparing Values, Behaviors, Institutions and Organizations Across Nations*,

Hofstede, G., 2011. Dimensionalizing Cultures : The Hofstede Model in Context.

Online Readings in Psychology and Culture, 2(1), pp.1–26.
Hofstede, G., 2006. What did GLOBE really measure? Researchers' minds versus respondents' minds. *Journal of International Business Studies*, 37(6), pp.882–896.
Hofstede, G., Hofstede, G.J. & Minkov, M., 2010. *Cultures and organizations: sofeware of the mind* 3rd ed., London: McGraw-Hill.
Hofstede, G.J.. P.B.P. & Hofstede, G., 2002. Exploring Culture: Exercises, Stories, and Synthetic Cultures. *Academy of Management Learning & Education*, pp.1–259.
Honey, P., 1979. The repertory grid in action: How to use it to conduct an attitude survey. *Industrial and Commercial Training*, 11(11), pp.452–459.
Horn, D. & Salvendy, G., 2006. Consumer-based assessment of product creativity: A review and reappraisal. *Human Factors and Ergonomics In Manufacturing*, 16(2), pp.155–175.
Horn, D. & Salvendy, G., 2009. Measuring consumer perception of product creativity: Impact on satisfaction and purchasability. *Human Factors and Ergonomics In Manufacturing*, 19(3), pp.223–240.
Hsieh, M. & Pan, S., 1995. Dimensions and Purchase Behavior : A Multicountry Analysis.
Hunter, M G and Beck, J.E., 2000. Using Repertory Grids to Conduc Cross-cultural Information Systems research. *Information Systems Research*, 11(1), pp.93–101.
Hunter, M.G., 1997. The use of RepGrids to gather interview data about information systems analysts. *Information Systems Journal*, 7(1), pp.67–81.
Imai, M., Kanero, J. & Masuda, T., 2016. The relation between language, culture, and thought. *Current Opinion in Psychology*, 8, pp.70–77.
Industrial design society of America, 2016. What is Industrial Design? Available at: http://www.idsa.org/education/what-is-industrial-design [Accessed April 20, 2016].
Ishii, K., 2013. Culture and the mode of thought: A review. *Asian Journal of Social Psychology*, 16(2), pp.123–132.
Jankowicz, D., 2003. *the Easy Guide To Repertory Grids*, Chichester: Wiley.
Ji, L.J., Peng, K. & Nisbett, R.E., 2000. Culture, control, and perception of relationships in the environment. *Journal of personality and social psychology*, 78(5), pp.943–955.
Ji, L.J. & Yap, S., 2016. Culture and cognition. *Current Opinion in Psychology*, 8, pp.105–111.
Ji, L.-J., Zhang, Z. & Nisbett, R.E., 2004. Is it culture or is it language? Examination of language effects in cross-cultural research on categorization. *Journal of personality and social psychology*, 87(1), pp.57–65.
Jordan, P.W., 2000. *Designing Pleasurable Products: an introduction to the new human factors*, London: Taylor & Francis.
Kelly, G., 1955. *A Theory of Personality: The psychology of personal constructs*, New York: Norton.
Khan, A. & Rayner, G.D., 2003. Robustness to non-normality of common tests for the many-sample location problem. *Journal of Applied Mathematics and Decision Sciences*, 7(4), pp.187–206.

Kluckhohn, F.R. & Strodtbeck, F.L., 1961. *Variations in value orientations*, Westport: CT Greenwood Press.

Korac-Kakabadse, N., Kouzmin, A., Korac-Kakabadse, A. & Savery, L., 2001. Low- and high-context communication patterns: towards mapping cross-cultural encounters. *Cross Cultural Management: An International Journal*, 8(2), pp.3–24.

Kuniavsky, M., 2012. *Observing the User Experience: A Practitioner's Guide to User Research*, Waltham: Morgan Kaufmann.

Laerd Statistics, 2016. THREE-WAY MIXED ANOVA (BBW). Available at: Laerd Statistics [Accessed May 11, 2016].

Lähteenmäki, M. & Kaikkonen, A., 2004. Designing for aged people communication needs. *HCI and Older Population. University of Glasgow*, (September), pp.19–20.

Lai, J., Honda, T. & Yang, M.C., 2010. A study of the role of user-centered design methods in design team projects. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, 24(03), pp.303–316.

Lake, A.J., Staiger, P.K. & Glowinski, H., 2000. Effect of Western culture on women's attitudes to eating and perceptions of body shape. *International Journal of Eating Disorders*, 27(1), pp.83–89.

Van Lamsweerde, A., 2001. Goal-oriented requirements engineering: a guided tour. *Proceedings Fifth IEEE International Symposium on Requirements Engineering*, pp.249–262.

Laroche, M., Bergeron, J. & Barbaro-Forleo, G., 2001. Targeting consumers who are willing to pay more for environmentally friendly products. *Journal of Consumer Marketing*, 18(6), pp.503–520.

Lawson, B., 2006. *How designers think: the design process demystified* 4th ed., London and New York: Routledge.

Lin, Y., 1938. *My Country and My People*, London: Heinemann: Readers' Union.

Liu, G., 2015. Inheritance and Innovation Based on the Hundred Years of Chinese Industrial Design (In Chinese). *Design research*, 5(5).

Lloyd, P., Lawson, B. & Scott, P., 1995. Can concurrent verbalization reveal design cognition? *Design Studies*, 16(2), pp.237–259.

Lundholm, H., 1921. The Affective Tone of Lines: Experimental Researches. *Psychological Review*, 28(1), p.43.

Marcus, A., 2003. User-interface design and China. *Interactions*, 10(1), p.21.

Marcus, A. & Gould, E.W., 2000. Crosscurrents: cultural dimensions and global Web user-interface design. *Interactions*, 7(4), pp.32–46.

Markus, H.R. & Kitayama, S., 1991. Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review*, 98(2), pp.224–253.

McGown, A., Green, G. & Rodgers, P. a, 1998. Visible ideas: information patterns of conceptual sketch activity. *Design Studies*, 19(4), pp.431–453.

McNaught, C. & Lam, P., 2010. Using wordle as a supplementary research tool. *Qualitative Report*, 15(3), pp.630–643.

Mcsweeney, B., 2002. Hofstede ' s Model of National Cultural Differences and Their Consequences : A Triumph of Faith — a Failure of Analysis Human Relations. *Human relations*, 55(February), pp.89–118.

Menezes, A. & Lawson, B., 2006. How designers perceive sketches. *Design Studies*, 27(5), pp.571–585.

Miller, J.G., 1984. Culture and development of everyday social explanation. *Journal of Personality and Social Psychology*, 46(5), pp.961–978.

Miller, M.N. & Pumariega, A.J., 2001. Culture and Eating Disorders: A Historical and Cross Cultural Review. *Psychiatry*, 64(2), pp.93–110.

Miller, W., 2005. Definition of design. *Trimtab, Buckminster Fuller Institute*.

Moalosi, R., 2007. *The Impact of Socio-cultural Factors upon Human-centred Design in Botswana*. Thesis, (PhD). Queensland University of Technology.

Morden, T., 1999. Models of National Culture - A Management Review. *Cross Cultural Management: An International Journal*, 6(1), pp.19–44.

Naoi, T., Airey, D., Iijima, S. & Niininen, O., 2006. Visitors' evaluation of an historical district: Repertory Grid Analysis and Laddering Analysis with photographs. *Tourism Management*, 27(3), pp.420–436.

Niinimäki, K., 2010. Eco-Clothing, consumer identity and ideology. *Sustainable Development*, 18(3), pp.150–162.

Nikander, J.B., Liikkanen, L. a. & Laakso, M., 2014. The preference effect in design concept evaluation. *Design Studies*, 35(5), pp.473–499. Available at: http://dx.doi.org/10.1016/j.destud.2014.02.006.

Nisbett, R.E., Peng, K., Choi, I. & Norenzayan, A., 2001. Culture and Systems of Thought. *Psychological Review*, 108(2), pp.291–310.

Norman, D.N., 2004. *Emotional Design - Why we love (or hate) everyday things*,

Norman, G., 2010. Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education*, 15(5), pp.625–632.

Northrop, F.S.C., 1946. *The meeting of East and West: An inquiry concerning world understanding*, New York: Macmillan.

OFNS, 2015. Internet users: 2015. Available at: http://www.ons.gov.uk/businessindustryandtrade/itandinternetindustry/bulletins/internetusers/2015 [Accessed November 5, 2016].

Oman, S.K., Tumer, I.Y., Wood, K. & Seepersad, C., 2013. A comparison of creativity and innovation metrics and sample validation through in-class design projects. *Research in Engineering Design*, 24, pp.65–92.

Osborne, J.W. & Overton, A., 2004. The power of outliers (and why researchers should always check for them). *Practical Assessment, Research & Evaluation*, 9, p.Retrieved June 1, 2012 from http://PAREonline.net/.

Oshlyansky, L., Cairns, P. & Thimbleby, H., 2004. Breaking Affordance : Culture as Context. *Proceedings of the third Nordic conference on Human-computer interaction*, pp.81–84.

Oyugi, C., Dunckley, L. & Smith, A., 2008. Evaluation methods and cultural differences: studies across three continents. *NordiCHI '08: Proceedings of the 5th Nordic conference on Human-computer interaction: building bridges*, pp.318–325.

Passini, S., 2013. A binge-consuming culture: The effect of consumerism on social interactions in western societies. *Culture & Psychology*, 19(3), pp.369–390.

Pike, S., 2004. The use of repertory grid analysis and importance-performance analysis to identify potential determinant university attributes. *Journal of Marketing for Higher Education*, 14(2), pp.1–18.

Preece, J., Rogers, Y. & Sharp, H., 2002. Interaction Design: Beyond Human-Computer Interaction. *Design*, 18(1), pp.68–68.

Purcell, a. T. & Gero, J.S., 1998. Drawings and the design process. *Design Studies*, 19(4), pp.389–430.

Quinn, J.M. & Tran, T.Q., 2010. Attractive Phones Don't Have To Work Better: Independent Effects of Attractiveness, Effectiveness, and Efficiency on Perceived Usability. *Proceeding CHI '10 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp.353–362.

Ralph, P. & Wand, Y., 2009. A Proposal for a Formal Definition of the Design Concept. In *Design Requirements Workshop*. pp. 103–136.

Rau, P.-L.P., Choong, Y.-Y. & Salvendy, G., 2004. A cross cultural study on knowledge representation and structure in human computer interfaces. *International Journal of Industrial Ergonomics*, 34(2), pp.117–129.

Razzaghi, M. & Ramirez, M., 2009. Cultural affordance of products: coverage within industrial design education. *Proceedings of the 11th International Conference on Engineering and Product Design Education EPDE09*, (September), pp.483–488.

Razzaghi, M., Ramirez, M. & Zehner, R., 2009. Cultural patterns in product design ideas: comparisons between Australian and Iranian student concepts. *Design Studies*, 30(4), pp.438–461.

Redding, S.G., 1994. Comparative Management Theory: Jungle, Zoo or Fossil Bed? *Organization Studies*, 15(3), pp.323–359.

Redström, J., 2006. Towards user design? on the shift from object to user as the subject of design. *Design Studies*, 27(2), pp.123–139.

Reid, V., 2011. A study of the influence of individual-level cultural value orientation on the formation of service quality expections. , (July).

Roberts, K.H. & Boyacigiller, N.A., 1984. Cross-national organizational research. The grasp of the blind men. In *Research in organizational behavior*. pp. 17–31.

Rodgers, P.A., Road, C., Green, G. & Mcgown, A., 2000. Using concept sketches to track design progress. , 21, pp.451–464.

Rodrigues, C. a., 1998. Cultural classifications of societies and how they affect cross-cultural management. *Cross Cultural Management: An International Journal*, 5(3), pp.31–41.

Schein, E.H., 1984. Coming to a new awareness of organisational culture. *Sloan management review*, 25(2), p.3.

Schön, D., 1991. *The Reflective Practitioner: How professional think in action* 2nd ed., Aldershot: Ashgate.

Schwartz, S., 1999. A Theory of Cultural Values and Some Implications for Work. *Applied Psychology*, 48(1), p.23.

Schwartz, S.H., 1994. Are There Universal Aspects in the Structure and Contents of Human Values? *Journal of Social Issues*, 50(4), pp.19–45.

Schwartz, S.H., 1992. Universals in the Content and Structure of Values: Theoretical Advances and Empirical Tests in 20 Countries. *Advances in Experimental Social Psychology*, 25(C), pp.1–65.

Schwartz, S.H. & Bardi, A., 2001. Taking a Similarities Perspective. *Journal of Cross-cultural Psychology*, 32(3), pp.268–290.

Seitamaa-Hakkarainen, P. & Hakkarainen, K., 1995. Visualization and Sketching in the Design Process. *The Design Journal*, 3(1), pp.3–14.

Seva, R.R. & Helander, M.G., 2009. The influence of cellular phone attributes on users' affective experiences: A cultural comparison. *International Journal of Industrial Ergonomics*, 39(2), pp.341–346.

Sharp, H., Lotz, N., Blyth, R., Woodroffe, M., et al., 2013. A protocol study of novice interaction design behaviour in Botswana: Solution-driven interaction design. *27th International British Computer Society Human Computer Interaction Conference: The Internet of Things, HCI 2013*.

Sharples, S. & Cobb, S., 2015. Methods for collecting and observing participant reponses. In J. R. Wilson & S. Sharples, eds. *Evaluation of human work*. London and New York: CRC Press, pp. 83–118.

Shaw, M.L., 1980. *On becoming a personal scientist: Interactive computer elicitation of personal models of the world*, Saunders College Publishing.

Shen, F. & Zhang, F., 2001. On Peculiarity of Industrial Design Education in Institutes of Technology (In Chinese). *Journal of Wuxi University of Light Industry*, 2(3).

Shen, S.T., Woolley, M. & Prior, S., 2006. Towards culture-centred design. *Interacting with Computers*, 18(4), pp.820–852.

Shi, Q., 2008. A field study of the relationship and communication between Chinese evaluators and users in thinking aloud usability tests. *Proceedings of the 5th Nordic conference on Human-computer interaction building bridges - NordiCHI '08*, p.344.

Shneiderman, B., 2000. Universal usability. *Communications of the ACM*, 43(5), pp.84–91.

Shockley-Zalabak, P. & Morley, D.D., 1986. Conflict avoiders and compromisers: Toward an understanding of their organizational communication style. *Group & Organization Management*, 11(4), pp.387–402.

Signorini, P., Wiesemes, R. & Murphy, R., 2009. Developing alternative frameworks for exploring intercultural learning: a critique of Hofstede's cultural difference model. *Teaching in Higher Education*, 14(3), pp.253–264.

Simon, H.A., 1996. *The Sciences of the Artificial* 3rd ed., MIT Press.

Slater, P., 1976. *The measurement of intrapersonal space by grid technique: I. Explorations of intrapersonal space*,

Snelders, D., Morel, K.P.N. & Havermans, P., 2011. The cultural adaptation of web design to local industry styles: A comparative study. *Design Studies*, 32(5), pp.457–481.

Sonderegger, A. & Sauer, J., 2010. The influence of design aesthetics in usability testing: Effects on user performance and perceived usability. *Applied Ergonomics*, 41(3), pp.403–410.

Sparke, P., 2013. *An introduction to design and culture: 1900 to the present*, London: Routledge.

Stanton, N.A. & Young, N.A., 1997. Ergonomics methods in consumer product design and evaluation. In *Human Factors in Consumer Products*. London: aylor and Francis, pp. 21–53.

Stasko, J., Görg, C. & Spence, R., 2008. Jigsaw: supporting investigative analysis through interactive visualization. *Information Visualization*, 7(2), pp.118–

132.
Suchman, L.A., 1987. *Plans and Situated Actions*, Cambridge: Cambridge University Press.
Sun, X., 2009. *Using Mobile Personalization to Enhance the User Experience at Large Sporting Events*.
Suwa, M. & Tversky, B., 1997. What do architects and students perceive in their design sketches? A protocol analysis. *Design Studies*, 18(4), pp.385–403.
Talcott, P. & Shils, E.A., 1951. *Toward a general theory of action*, Cambridge: Harvard University Press.
Tan, F.B. & Hunter, M.G., 2002. The repertory grid technique: A method for the study of cognition in information systems. *MIS Quarterly*, 26(1), pp.39–57.
Tang, H.H., Lee, Y.Y. & Gero, J.S., 2011. Comparing collaborative co-located and distributed design processes in digital and traditional sketching environments: A protocol study using the function-behaviour-structure coding scheme. *Design Studies*, 32(1), pp.1–29. Available at: http://dx.doi.org/10.1016/j.destud.2010.06.004.
Taras, V., Rowney, J. & Steel, P., 2009. Half a century of measuring culture: Review of approaches, challenges, and limitations based on the analysis of 121 instruments for quantifying culture. *Journal of International Management*, 15(4), pp.357–373.
Tellström, R., Gustafsson, I.-B. & Mossberg, L., 2006. Consuming heritage: The use of local food culture in branding. *Place Branding*, 2(2), pp.130–143.
Thang, B., Sluis-Thiescheffer, W., Bekker, T., Eggen, B., et al., 2008. Comparing the creativity of children's design solutions based on expert assessment. *Proceedings of the 7th international conference on Interaction design and children - IDC '08*, pp.266–273.
Tihanyi, L., Griffith, D.A. & Russell, C.J., 2005. The effect of cultural distance on entry mode choice, international diversification, and MNE performance: a meta-analysis. *Journal of International Business Studies*, 36(3), pp.270–283.
Tomico, O., Karapanos, E., Lévy, P., Mizutani, N., et al., 2009. The repertory grid technique as a method for the study of cultural differences. *International Journal of Design*, 3(3), pp.55–63.
Tovey, M., Porter, S., Newman, R. & Street, P., 2003. Sketching, concept development and automotive design. , 24, pp.135–153.
Triandis, H.C., McCusker, C. & Hui, C.H., 1990. Multimethod probes of individualism and collectivism. *Journal of Personality and Social Psychology*, 59(5), pp.1006–1020.
Trompenaars, F. & Hampden-Turner, C., 2012. *Riding the waves of culture : understanding diversity in global business* 3rd ed., London: Nicholas Brealey.
Vatrapu, R. & Perez-Quinones, M. a., 2004. Culture and International Usability Testing: The Effects of Culture in Structured Interviews. , p.8.
Veryzer, R. & Veryzer, J.R.W., 1995. The place of product design and aesthetics in consumer research. *Advances in consumer research*, 22(1), pp.783–785.
Wang, J., Zhao, J., Guo, S., North, C., et al., 2014. ReCloud : Semantics-Based Word Cloud Visualization of User Reviews. *Proceedings of Graphics Interface 2014 (GE'14)*, pp.151–158.
Williamson, D., 2002. Forward from a Critique of Hofstede's Model of National

Culture. *Human Relations*, 55(200211), pp.1373–1395.
Wilson, J. & Sharples, S., 2015. *Evaluation of Human Work*, CRC Press.
Wilson, J.R. & Sharples, S., 2015. Methods in the understanding of human factors. In J. R. Wilson & S. Sharples, eds. *Evaluation of human work*. London and New York: CRC Press, pp. 1–32.
Xia, L., 2014. Four Psychological Changes among Chinese People in the Past 20 years (in Chinese). *Soutnern Weekly*. Available at: http://www.guancha.cn/NanFangZhouMo/2014_08_31_262039.shtml.
Xu-Priour, D.L., Truong, Y. & Klink, R.R., 2014. The effects of collectivism and polychronic time orientation on online social interaction and shopping behavior: A comparative study between China and France. *Technological Forecasting and Social Change*, 88, pp.265–275.
Yamamoto, M. & Lambert, D.R., 1994. The Impact of Product Aesthetics on the Evaluation of Industrial Products. *Journal of Product Innovation Management*, 11(4), pp.309–324.
Yeo, A., 1998. Cultural Effects in Usability Assessment. *Proceedings of the SIGCHI conference on Human factors in computing systems*, (April), pp.74–75.
Yuan, X.Y., 2003. A research on the development of art and design education in China (in Chinese). *Beijing Institute of Technology Publishing*.
Zhang, Y., 1996. Chinese consumers' evaluation of foreign products: the influence of culture, product types and product presentation format. *European Journal of Marketing*, 30(12), pp.50–68.

APPENDICES

Appendix 4A: Participant information sheets and consent forms of Study 1

Comparison of students' work from UK and Ningbo campuses

Part 1

Participant information sheet

Thank you for participating in my study.

Introduction of the study

This study is part of a PhD programme that aims at investigating cultural differences in product design between UK and China. The study will collect design work (in paper format) from the module of Industrial Design from both UK and Ningbo campuses and compare aspects of the design such as ergonomics and aesthetics to investigate cultural differences.

This study consists of two parts. In Part 1, the researcher will collect the design work and the designers' demographic information from both campuses. In Part 2, the work will be evaluated by two groups of participants in both campuses: qualified designers (those who own a degree in product design) and the general public. (The participants will need to sign an agreement to protect the copyright of the students' work. A copyright declaration will also be attached to any publication related to this study.) Interviews will be used to collect the information for Part 2. The interview questions will be developed using the Repertory Grid* technique and the answers analysed using a content analysis methodology based on the interview.

* Repertory Grid is an interviewing technique for identifying the ways that a person interprets his or her experience. Repertory Grid in this study will be conducted in this way: during the interview, the participants will be asked to group the designs into two opposite descriptions (e.g. creative – uncreative) each time, and then rating each design in a 7-point rating scale system (e.g. If creative is the 1 end of the scale and uncreative the 7 end, one participant may rate one of the designs 1 because it seems to be creative to him/her according to his/her own experience).

Your participation in this study

Your participation is voluntary. If you do decide to take part you will be asked to sign a consent form. You can withdraw at any time without it affecting you or your academic performance in any way. You do not have to give a reason why.

We need you to authorize us to study your work from the module of Industrial Design. At the beginning, you have to complete a questionnaire regarding demographic information to make sure your background fits to this project. Then, your design work in the module of Industrial Design will be collected and analysed during further study.

Privacy and confidentiality

Your design work will be scanned and stored. Your work will be anonymised. No personal details relating to you and the results of this study will be used only for the purpose of research. All data will be anonymised and will be stored on a password-protected computer and deleted 7 years after any publication arising from the work. Data will only be accessible by people directly involved in the research (the researcher Fangyan Tang and her three supervisors: Dr. Glyn Lawson, Dr. Xu Sun & Prof. Sarah Sharples). No images will be used without the participants' permission.

No personal information will be associated with the work and it will not be possible to identify any individuals from data. You will be allocated a participant number and this will be used to identify the designer's demographic information.

The research project has been reviewed according to the ethical review processes in place at The University of Nottingham, Faculty of Engineering, and also the Ningbo campus. These processes are governed by the University's Code of Research Conduct and Research Ethics. Should you have any question now or in the future, please contact me or my supervisor. Should you have concerns related to my conduct of the survey or research ethics, please contact my supervisor or the University's Ethics Committee.

Thank you for taking the time to read this. If you have any question please do not hesitate to ask. Your participation in this study is very much appreciated.

Contact Information

Student Researcher: Fangyan Tang fangyan.tang@nottingham.ac.uk
Supervisors: Dr Glyn Lawson glyn.lawson@nottingham.ac.uk
Dr Xu Sun xu.sun@nottingham.edu.cn

Comparison of students' work from UK and Ningbo campuses

Part 1

Consent Form

- I have read the Participant Information Sheet and the nature and purpose of the research project has been explained to me. I understand and agree to take part.
- I understand the purpose of the research project and my involvement in it.
- I understand that I may withdraw from the research project at any stage and that this will not affect my status now or in the future.
- I understand that while information gained during the study may be published, I will not be identified and my personal results will remain confidential.
- I understand that data will be stored in accordance with data protection laws.
- I understand that I may contact the researcher or supervisor if I require more information about the research, and that I may contact the Research Ethics Sub-Committee of the University of Nottingham, Ningbo if I wish to make a complaint related to my involvement in the research.

On the basis of the information provided I am happy to participate.

Student Number ……..

Name (please print) ……..

Signed …….

Date and Time ……

Comparison of students' work from UK and Ningbo campuses

Part 2

Participant information sheet

Thank you for participating in my study.

Introduction of the study

This study is part of a PhD programme that aims at investigating cultural differences in product design between UK and China. The study will collect design work (in paper format) from the module of Industrial Design from both UK and Ningbo campuses and compare aspects of the design such as ergonomics and aesthetics to investigate cultural differences.

This study consists of two parts. In Part 1, the researcher will collect the design work and the designers' demographic information from both campuses. In Part 2, the work will be evaluated by two groups of participants in both campuses: qualified designers (those who own a degree in product design) and the general public. (The participants will need to sign an agreement to protect the copyright of the students' work. A copyright declaration will also be attached to any publication related to this study.) Interviews will be used to collect the information for Part 2. The interview questions will be developed using the Repertory Grid* technique and the answers analysed using a content analysis methodology based on the interview.

* Repertory Grid is an interviewing technique for identifying the ways that a person interprets his or her experience. Repertory Grid in this study will be conducted in this way: during the interview, the participants will be asked to group the designs into two opposite descriptions (e.g. creative – uncreative) each time, and then rating each design in a 7-point rating scale system (e.g. If creative is the 1 end of the scale and uncreative the 7 end, one participant may rate one of the designs 1 because it seems to be creative to him/her according to his/her own experience).

Your participation in this study

Your participation is voluntary. If you do decide to take part you will be given this information sheet and be asked to sign a consent form. You can withdraw at any time without affecting any benefits that you are entitled to in any way. You do not have to give a reason.

Before the beginning of the study you will be requested to complete a short questionnaire to collect some demographic information. During the interview,

you will be presented with examples of design work and asked for your opinions. The interview will take about 1.5 hours. You will receive a shopping voucher worth £10 / ¥60 in reward.

Privacy and confidentiality

You will be audio and/or video recorded during the interview (Your face will not be filmed. Only the movements of your hands and your voice will be recorded). The video material and the results of this study will be used only for the purpose of research and will not be broadcast or distributed to the public. All data will be anonymised and will be stored on a password-protected computer and deleted 7 years after any publication arising from the work. Data will only be accessible by people directly involved in the research (the researcher Fangyan Tang and her three supervisors: Dr. Glyn Lawson, Dr. Xu Sun & Prof. Sarah Sharples) . No images will be used without the participants' permission.

No personal information will be associated with your responses and it will not be possible to identify you from response data. You will be allocated a participant number and this will be used to identify your responses.

The research project has been reviewed according to the ethical review processes in place at the University of Nottingham, Faculty of Engineering, and also the Ningbo campus. These processes are governed by the University's Code of Research Conduct and Research Ethics. Should you have any question now or in the future, please contact me or my supervisor. Should you have concerns related to my conduct of the survey or research ethics, please contact my supervisor or the University's Ethics Committee.

Thank you for taking the time to read this. If you have any question please do not hesitate to ask. Your participation in this study is very much appreciated.

Contact Details:

Student Researcher: Fangyan Tang fangyan.tang@nottingham.ac.uk
Supervisors: Dr Glyn Lawson glyn.lawson@nottingham.ac.uk
Dr Xu Sun xu.sun@nottingham.edu.cn

Comparison of students' work from UK and Ningbo campuses

Part 2

Consent Form

- I confirm that I have read and understood the information sheet for the above study which I may keep for my records and I have had the opportunity to ask any initial questions I may have.

- I agree to take part in the above study and I am willing to:
  - Participate in an interview
  - Provide responses based on my experience
  - Be recorded in audio and/or video whilst engaged in the study

- I understand that my information will be held and used for the following purposes:
  - Investigation into the difference of design culture between UK and China
  - Dissemination of findings through academic publications

- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without being penalized or disadvantaged in any way.

On the basis of the information provided I am happy to participate.

Name (please print) ……..

Signed ……

Date and Time ……..

Appendix 4B: Results of Core-categorisation and Honey's content analysis

Category		Constructs	% similarity	H-I-L indices	No	%
Aesthetics	1	UK-2-9 aesthetics-pleasing--ugly	57.41	H	**46**	**15.44**
	2	UK-3-8 low visually-appealing--high visually-appealing	53.7	H		
	3	UK-6-8 aesthetic--not aesthetic	68.52	H		
	4	UK-8-10 pleasing to the eye--not pleasing to the eye	59.26	H		
	5	UK-10-7 pleasing to look at--not pleasing to look at	62.96	H		
	6	UK-11-7 not aesthetically appealing--aesthetically appealing	88.89	H		
	7	UK-1-2 colourful--plain	37.04	I		
	8	UK-4-12 looks good--ugly	64.81	I		
	9	UK-5-10 attractive--not attractive	62.96	I		
	10	UK-9-7 appealing to you--not appealing	50	I		
	11	UK-1-10 good-looking--not good-looking	31.48	L		
	12	UK-3-6 less colourful--more colourful	18.52	L		
	13	UK-5-13 aesthetic--not aesthetic	48.15	L		
	14	UK-8-9 single colour--many colour	25.93	L		
	15	UK-10-2 neutral--colourful	24.07	L		
	16	UK-11-2 no colour--colourful	33.33	L		
	17	UK-D1-11 not pleasing to look at--pleasing to look at	75.93	H		
	18	UK-D2-6 not aesthetically pleasing--really aesthetically pleasing	64.81	H		
	19	UK-D4-11 low in aesthetics--high in aesthetics	62.96	H		
	20	UK-D5-10 low in aesthetics--high in aesthetics	74.07	H		
	21	UK-D3-11 low aesthetically pleasing--high aesthetically pleasing	68.52	I		
	22	UK-D4-3 not colourful--colourful	18.52	L		
	23	UK-D4-4 low amount of colour--high amount of colour	20.37	L		
	24	CN-1-6 not good-looking--with a sense of design, good-looking	55.56	H		
	25	CN-2-9 not good-looking--good-looking	81.48	H		
	26	CN-3-10 not good-looking--good-looking	61.11	H		
	27	CN-4-8 with no colour--with strong and bright colour	74.07	H		
	28	CN-5-2 not pleasing to the eye--pleasing to the eye	74.07	H		
	29	CN-6-6 not good looking--good-looking	79.63	H		
	30	CN-8-9 low-aesthetic--high-aesthetic	74.07	H		
	31	CN-9-10 not aesthetic--aesthetic	74.07	H		
	32	CN-10-8 not aesthetic--aesthetic	70.37	H		
	33	CN-2-5 with no colour--many colours	50	I		
	34	CN-4-3 low decoration value--high decoration value	62.96	I		
	35	CN-11-7 not aesthetic--aesthetic	57.41	I		
	36	CN-9-7 with no colour--multiple colours	25.93	L		
	37	CN-10-7 single-colour--colourful	29.63	L		

	38	CN-D1-10 not pleasing to the eye--pleasing to the eye	64.81	H		
	39	CN-D2-10 not appealing to the eye--appealing to the eye	57.41	H		
	40	CN-D3-10 not appealing to the eye--appealing to the eye	61.11	H		
	41	CN-D4-9 not appealing to the eye--appealing to the eye	90.74	H		
	42	CN-D5-2 single in colour--rich in colour	51.85	H		
	43	CN-D4-4 single in colour--rich in colour	51.85	I		
	44	CN-D2-6 dull colour--bright colour	37.04	L		
	45	CN-D3-7 with no colour--with bright colour	37.04	L		
	46	CN-D5-10 not appealing to the eye--appealing to the eye	35.19	L		
Form / structure	1	UK-3-1 complex--simple	42.59	H	**75**	**25.17**
	2	UK-4-2 curved lines--jagged lines	72.22	H		
	3	UK-5-1 with obvious bin--with no obvious bin	70.37	H		
	4	UK-6-4 traditional in shape--modern in shape	53.7	H		
	5	UK-8-3 curved lines--straight lines	57.41	H		
	6	UK-10-3 rounded shape and lines--angular shape and lines	64.81	H		
	7	UK-11-4 not many containers--lots of containers	70.37	H		
	8	UK-1-1 simple, one piece--complex	40.74	I		
	9	UK-2-2 simple--complex	48.15	I		
	10	UK-2-3 spread out--compact	42.59	I		
	11	UK-4-1 simple shapes--complex shapes	59.26	I		
	12	UK-4-3 with clear pockets--with no clear pocket	57.41	I		
	13	UK-5-9 modular--unitary	57.41	I		
	14	UK-6-6 less compartments--more compartments	40.74	I		
	15	UK-8-5 without moving parts--with moving parts	27.78	I		
	16	UK-10-1 enclosed shape--open shape	50	I		
	17	UK-11-3 rounded sides--straight sides	66.67	I		
	18	UK-11-6 small size--big size	59.26	I		
	19	UK-1-8 customisable, changeable--rigid, inflexible, not customisable	16.67	L		
	20	UK-2-1 upright--side ways	7.41	L		
	21	UK-2-5 flexible--rigid	29.63	L		
	22	UK-3-4 less foldable--more foldable	27.78	L		
	23	UK-3-5 non-movable parts--movable parts	29.63	L		
	24	UK-4-7 with moving parts--with no moving parts	18.52	L		
	25	UK-4-8 clear moving parts--not clear moving parts	37.04	L		
	26	UK-6-2 concentrated--separated	33.33	L		
	27	UK-6-5 regular shapes--irregular shapes	35.19	L		
	28	UK-10-4 cylinder shape--square shape	42.59	L		
	29	UK-11-1 cannot be configured/rearranged--can be configured	38.89	L		
	30	UK-D3-5 low complexity in structure--high complexity in structure	70.37	H		

31	UK-D4-1 square form--rounded form	42.59	I		
32	UK-D4-2 complex--simple	44.44	I		
33	UK-D1-2 1 piece--7 or more pieces	27.78	L		
34	UK-D1-4 modular--not modular	12.96	L		
35	UK-D2-3 not customisable--customisable	44.44	L		
36	UK-D5-3 several parts--one single unit	20.37	L		
37	CN-4-1 singularity--combination	75.93	H		
38	CN-3-1 succinct structure--complex structure	50	I		
39	CN-3-3 lay transversely--lay vertically	44.44	I		
40	CN-4-2 regular, equal compartments, simple structure--diverse and complex structure	57.41	I		
41	CN-4-6 fixed structure--changeable structure	50	I		
42	CN-6-4 single compartment--many compartments	51.85	I		
43	CN-8-1 rounded shape--squared shape	46.3	I		
44	CN-10-1 ellipse, round elements in structure--irregular, liberal structure	64.81	I		
45	CN-11-3 single component--combination of many components	55.56	I		
46	CN-11-4 formal structure--amusing structure	57.41	I		
47	CN-1-4 low flexibility--high flexibility	42.59	L		
48	CN-2-1 square and regular shape--irregular shape	44.44	L		
49	CN-2-3 fixed structure--movable structure	42.59	L		
50	CN-2-8 with enclosed space (private)--totally open space	27.78	L		
51	CN-3-5 standing style--hanging style	5.56	L		
52	CN-5-3 natural flowing lines--rigid and stiff lines	57.41	L		
53	CN-5-4 not movable, static, rigid--with moving content, changeable	61.11	L		
54	CN-6-2 not definite shape--definite shape	48.15	L		
55	CN-6-3 displayed vertically--could be displayed in multiple ways	27.78	L		
56	CN-8-4 fixed structure--changeable structure	31.48	L		
57	CN-8-6 regular geometrical figures--irregular, asymmetric figures	31.48	L		
58	CN-10-4 low flexibility--high flexibility	46.3	L		
59	CN-11-6 square-shaped--round-shaped	46.3	L		
60	CN-D1-2 single compartment--multiple compartments	53.7	H		
61	CN-D2-4 straight-line style--organic curved-line style	59.26	H		
62	CN-D3-4 regular in the form of the openings--various in the form of the openings	62.69	H		
63	CN-D4-5 rigid in overall form--organic in overall form	70.37	H		
64	CN-D1-1 groove style--shelf style	48.15	I		
65	CN-D1-3 simple geometric form--complex form	38.89	I		
66	CN-D1-4 with movable and hided space--without movable and hided space	35.19	I		
67	CN-D3-3 round-form--square-form	55.56	I		
68	CN-D3-5 closed space, for storing things--open space, for displaying things	51.85	I		
69	CN-D4-2 round in shape of the compartments--square in the shape of the	50	I		

		compartments				
	70	CN-D4-3 weak in the feeling of wholeness, decentralised--strong in the feeling of wholeness	46.3	I		
	71	CN-D5-1 round in overall form--square in overall form	46.3	I		
	72	CN-D2-3 static structure, without movable component--dynamic structure, with movable structure	40.74	L		
	73	CN-D3-1 fixed structure--changeable structure	42.59	L		
	74	CN-D3-6 single component--multiple components	44.44	L		
	75	CN-D4-1 big difference between dimensions--balance proportion between dimensions	42.59	L		
Functionality	1	UK-3-2 storage of less stationery--storage of more stationery	50	H	**22**	**7.38**
	2	UK-3-10 less variety of stationery stored--more variety of stationery stored	37.04	I		
	3	UK-5-5 single function--more functions	64.81	I		
	4	UK-6-1 traditional in function--alternative in function	46.3	I		
	5	UK-1-5multiple uses, for all kinds of stationery--single use, just for pens	22.22	L		
	6	UK-4-5 high variety of storage options--low variety of storage options	35.19	L		
	7	UK-6-7 limited function--additional function	31.48	L		
	8	UK-8-6 no area for computer--area for computer	1.85	L		
	9	UK-9-3 obvious functionality--vague functionality	35.19	L		
	10	UK-9-4 obvious on how to display--vague on how to display	35.19	L		
	11	UK-D2-2 one function--multiple function	62.69	I		
	12	UK-D2-5 specific place for things--anything can do anywhere	25.93	L		
	13	UK-D5-2 organizing/pieces organizer--containing/pieces container	25.93	L		
	14	CN-1-2 low diversity of the functionality--high diversity of the functionality	51.85	H		
	15	CN-5-1 simple container, simple functionality--systemic functionality, integrated and complex	72.22	H		
	16	CN-8-5 little storage space--lots of storage space	55.56	H		
	17	CN-9-2 single functionality--multiple functionality	68.52	H		
	18	CN-10-6 can only store one kind of stationery--can store many kinds of stationery	61.11	I		
	19	CN-11-1 single functionality--multiple functionality	55.56	I		
	20	CN-1-7 not practical or functional--practical, meets the requirements	38.89	L		
	21	CN-D3-2 single-functionality--multi-functionality	57.41	I		
	22	CN-D4-6 weak in functionality--strong in functionality	44.44	L		
Usability	1	UK-1-12 easy to use--difficult to use	42.59	H	**60**	**20.13**
	2	UK-3-7 high ease of storage--low ease of storage	46.3	H		
	3	UK-3-12 less useful--more useful	42.59	H		
	4	UK-4-9 easy to use--difficult to use	72.22	H		

	5	UK-4-11 high-usefulness--low-usefulness	77.78	H		
	6	UK-4-13 high durability--low durability	85.19	H		
	7	UK-5-11 ergonomic--not ergonomic	74.07	H		
	8	UK-6-9 easy to use--difficult to use	55.56	H		
	9	UK-8-11 practical in use--not practical in use	53.7	H		
	10	UK-10-5 easy to use--difficult to use	83.33	H		
	11	UK-11-8 not ergonomic--ergonomic	90.74	H		
	12	UK-2-6 ergonomic--not ergonomic	44.44	I		
	13	UK-3-3 less straightforward to use--more straightforward to use	37.04	I		
	14	UK-3-11 less ergonomic--more well ergonomically designed	37.04	I		
	15	UK-4-10 easy to display on the desk--difficult to display on the desk	66.67	I		
	16	UK-6-3 useful--limited use	48.15	I		
	17	UK-8-2 vertically put in stationery--horizontally put in stationery	35.19	I		
	18	UK-8-12 easy to use--difficult to use	37.04	I		
	19	UK-8-14 easy to clean--difficult to clean	42.59	I		
	20	UK-8-15 intrusive--not intrusive	38.89	I		
	21	UK-9-1 simple in ergonomics--complex in ergonomics	40.74	I		
	22	UK-10-8 easy to fit to the desk--difficult to fit to the desk	57.41	I		
	23	UK-2-8 useful--restricted	35.19	L		
	24	UK-8-1 stand on the desk--put on the wall	1.85	L		
	25	UK-D1-8 not practical--practical	57.41	H		
	26	UK-D1-9 ergonomic--not ergonomic	68.52	H		
	27	UK-D4-7 little consideration of user--lots of consideration of user	53.7	H		
	28	UK-D3-10 low in ergonomics--high in ergonomics	57.41	I		
	29	UK-D5-6 simple user-interaction--complex user-interaction	42.59	I		
	30	UK-D5-8 high in ergonomics--low in ergonomics	40.74	I		
	31	UK-D2-4 easy to use--difficult to use	38.89	L		
	32	UK-D3-1 sit on the desk--wall-mounted	7.41	L		
	33	CN-1-5 small space occupation--large space occupation	62.96	H		
	34	CN-2-4 practical--impractical	74.07	H		
	35	CN-2-10 not convenient, not practical--convenient, practical	70.37	H		
	36	CN-3-8 doesn't meet your requirements for a stationery rack--meet your requirement for a stationery rack	62.96	H		
	37	CN-4-4 low practicality, can store less things--high practicality, can store more things	70.37	H		
	38	CN-6-5 low practicality--high practicality	77.78	H		
	39	CN-6-8 low human-oriented--high human-oriented	70.37	H		
	40	CN-9-3 closed-not convenient in using--opened-convenient in using	72.22	H		
	41	CN-10-2 low practicality--high practicality	68.52	H		
	42	CN-10-9 not convenient to use--convenient to use	72.22	H		
	43	CN-11-9 low practicality--high practicality	72.22	H		

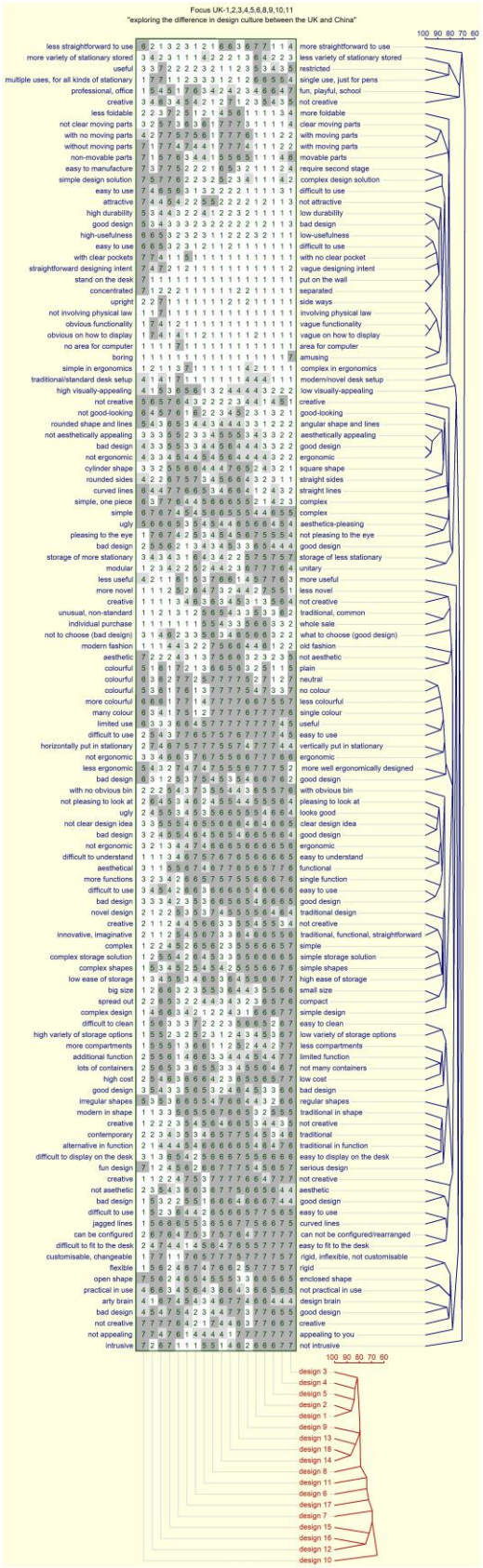
	44	CN-1-3 not convenient when using--convenient when using	50	I		
	45	CN-5-5 unpractical, garish, weak in function--practical, not garish, strong in function	62.96	I		
	46	CN-5-6 not convenient in using--convenient in using	66.67	I		
	47	CN-8-7 not considering user's habits--considering user's habits	46.3	I		
	48	CN-9-4 used at home--used at office (studying or working)	44.44	I		
	49	CN-3-6 inconvenient when suing--convenient when using	27.78	L		
	50	CN-3-7 not practical, low space efficiency--practical, rational use of space	42.59	L		
	51	CN-4-5 doesn't meet your requirement for stationery rack--totally meet you requirements	42.59	L		
	52	CN-10-5 occupies small space--occupies large space	46.3	L		
	53	CN-D1-9 unpractical--practical	61.11	H		
	54	CN-D2-11 unpractical--practical	74.07	H		
	55	CN-D2-8 low in convenience in operating--high in convenience in operating	51.85	I		
	56	CN-D3-9 not practical--practical	57.41	I		
	57	CN-D5-9 unpractical--practical	42.59	I		
	58	CN-D1-6 hung on the wall--displayed on the desk	7.41	L		
	59	CN-D2-2 stored vertically--stored horizontally	33.33	L		
	60	CN-D4-8 unpractical--practical	33.33	L		
Creativity	1	UK-2-4 innovative, imaginative--traditional, functional, straightforward	50	H	**29**	**9.73**
	2	UK-2-7 creative--not creative	55.56	H		
	3	UK-6-10 creative--not creative	53.7	H		
	4	UK-8-13 creative--not creative	50	H		
	5	UK-9-6 creative--not creative	61.11	H		
	6	UK-1-4 traditional, common--unusual, non-standard	40.74	I		
	7	UK-1-11 creative--not creative	37.04	I		
	8	UK-3-9 less novel--more novel	37.04	I		
	9	UK-10-6 creative--not creative	57.41	I		
	10	UK-5-12 creative--not creative	48.15	L		
	11	UK-9-5 traditional/standard desk setup--modern/novel desk setup	33.33	L		
	12	UK-D2-7 not creative--creative	68.52	H		
	13	UK-D3-2 more expected solution--more creative/unexpected solution	72.22	H		
	14	UK-D5-9 low in creativity--high in creativity	59.26	H		
	15	UK-D1-10 not creative--creative	50	I		
	16	UK-D4-10 low in creativity--high in creativity	50	I		
	17	CN-3-9 not creative--creative	61.11	H		
	18	CN-4-7 not creative--creative	74.07	H		
	19	CN-8-8 not creative--creative	77.78	H		
	20	CN-11-8 traditional, common in the market--creative, novel, unique structure	70.37	H		
	21	CN-2-2 traditional, common--creative, uncommon	53.7	I		

		22	CN-5-8 not creative--creative	64.81	I		
		23	CN-6-7 not creative--creative	64.81	I		
		24	CN-9-6 traditional in material, function, structure--novel, unique	46.3	I		
		25	CN-10-3 not creative, common--creative, novel	53.7	I		
		26	CN-D3-8 creative--not creative	72.22	H		
		27	CN-D1-8 uncreative--very creative	44.44	I		
		28	CN-D2-9 uncreative--creative	50	I		
		29	CN-D5-11 uncreative--creative	38.89	I		
Manufacture		1	UK-1-6 easy to manufacture--require second stage	50	H	**5**	**1.68**
		2	UK-D4-5 not suitable for manufacture--suitable for manufacture	57.41	H		
		3	UK-D4-6 low level of detailed information of manufacture--high level of detailed information of manufacture	50	I		
		4	UK-D1-1 complicated moulding tool--simple moulding tool	24.07	L		
		5	CN-9-9 design does not coincide with manufacturing process--design coincides with manufacturing process	53.7	I		
Judgements based on the design process	**Design process**	1	UK-5-2 clear design idea--not clear design idea	81.48	H	**11**	**3.69**
		2	UK-9-2 arty brain--design brain	64.81	H		
		3	UK-4-6 straightforward designing intent--vague designing intent	62.96	I		
		4	UK-D4-9 low amount of development of concepts--high amount of development of concepts	66.67	H		
		5	UK-D1-7 focus on function--focus on appearance	46.3	I		
		6	UK-D2-1 not thought through--thought through	62.96	I		
		7	UK-D4-8 low amount of concepts--high amount of concepts	31.48	L		
		8	UK-D5-11 thought more broadly--take a more conventional route	29.63	L		
		9	CN-6-1 design idea starts from abstract shape--design idea starts from existing image	70.37	H		
		10	CN-8-3 realistic method--analogue method	50	I		
		11	CN-11-5 focus on functionality--focus on ornamental features	40.74	L		
	Drawing / presentation	1	UK-5-7 easy to understand--difficult to understand	59.26	I	**14**	**4.7**
		2	UK-D3-3 low quality of visual presentation--high quality of visual presentation	72.22	H		
		3	UK-D1-3 not rendered--rendered	44.44	I		
		4	UK-D3-4 not using colour and tone--using colour and tone	57.41	I		
		5	UK-D3-9 low ability of drawing--high ability of drawing	53.7	I		
		6	UK-D5-4 visually easy to understand--visually difficult to understand	38.89	I		
		7	CN-11-2 straightforward--not straightforward	46.3	L		
		8	CN-D2-7 weak in skill of sketching--proficient in skill of sketching	68.52	H		
		9	CN-D5-7 weak three-dimensional effect--strong three-dimensional effect	53.7	H		
		10	CN-D5-8 with no text of explaining--with pages of explaining text	59.26	H		

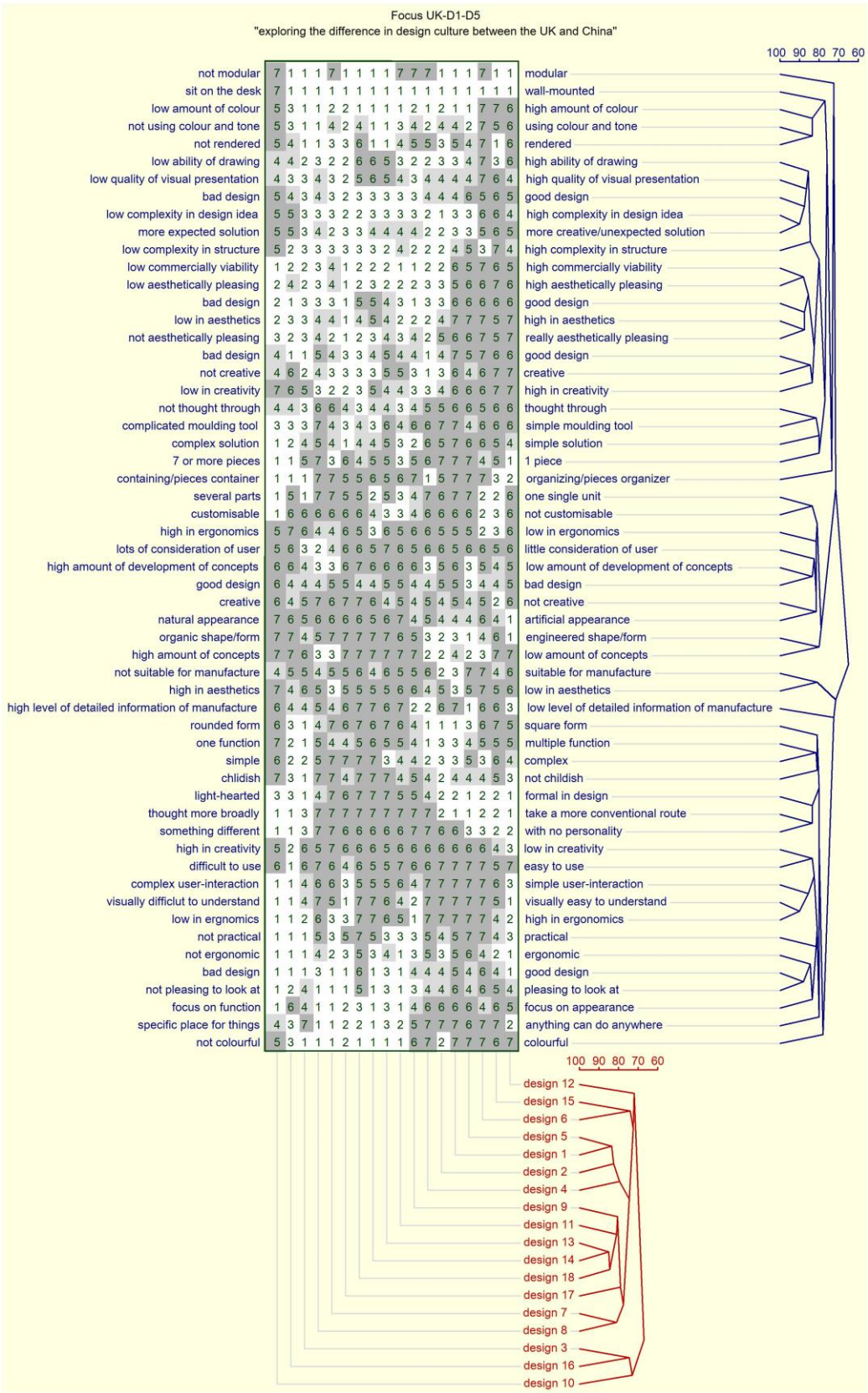
		11	CN-D5-4 weak quality of expression--strong quality of expression	48.15	I		
		12	CN-D5-3 sketching--photo	12.96	L		
		13	CN-D5-5 explaining--showing	25.93	L		
		14	CN-D5-6 single axonometric drawing--axonometric drawing + sectional drawing	22.22	L		
	Design style	1	UK-1-9 complex design solution--simple design solution	48.15	H	**28**	**9.4**
		2	UK-5-4 simple storage solution--complex storage solution	72.22	H		
		3	UK-8-4 complex design--simple design	51.85	H		
		4	UK-1-3 fun, playful, school--professional, office	40.74	I		
		5	UK-5-6 functional--aesthetical	66.67	I		
		6	UK-11-5 traditional design--novel design	46.3	I		
		7	UK-4-4 modern fashion--old fashion	27.78	L		
		8	UK-5-3 traditional--contemporary	51.85	L		
		9	UK-5-8 serious design--fun design	44.44	L		
		10	UK-8-8 boring--amusing	5.56	L		
		11	UK-D1-5 artificial appearance--natural appearance	53.7	H		
		12	UK-D3-6 low complexity in design idea--high complexity in design idea	74.07	H		
		13	UK-D5-1 complex solution--simple solution	64.81	H		
		14	UK-D1-6 not childish--childish	33.33	I		
		15	UK-D5-5 organic shape/form--engineered shape/form	40.74	I		
		16	UK-D3-8 with no personality--something different	50	L		
		17	UK-D5-7 formal in design--light-hearted	37.04	L		
		18	CN-3-2 cartoon style, vivid image--normative, traditional, formal	64.81	H		
		19	CN-1-1 common--not common	44.44	I		
		20	CN-2-7 childish--mature, official	53.7	I		
		21	CN-9-1 mature, formal style--childish style	42.59	I		
		22	CN-2-6 with natural elements or prototypes--artificial design	27.78	L		
		23	CN-5-7 art style, more about liberty, more human-oriented--engineering style, more about preciseness	61.11	L		
		24	CN-8-2 high functionality--high artistic quality	33.33	L		
		25	CN-D4-7 boring--interesting	72.22	H		
		26	CN-D2-1 tends to style, appearance, form--tend to function	55.56	I		
		27	CN-D1-7 simple geometric form, more abstract--using analogue, with vivid image	16.67	L		
		28	CN-D2-5 abstract--concrete	44.44	L		
Commercial aspect		1	UK-1-7 individual purchase--whole sale	40.74	I	**5**	**1.68**
		2	UK-6-11 low cost--high cost	35.19	L		
		3	UK-D3-7 low commercially viability--high commercially viability	51.85	L		
		4	CN-9-5 not suitable for gifting (formal, boring)--suitable for gifting (characteristic, interesting, compact)	42.59	I		
		5	CN-9-8 low cost--high cost	27.78	L		
Miscellaneous		1	UK-8-7 not involving physical law--involving	9.26	L	**3**	**1.01**

		physical law				
	2	CN-3-4 simple in technology--complex in technology	48.15	I		
	3	CN-D1-5 without extra material--with extra material	12.96	L		
Totals					**298**	**100**

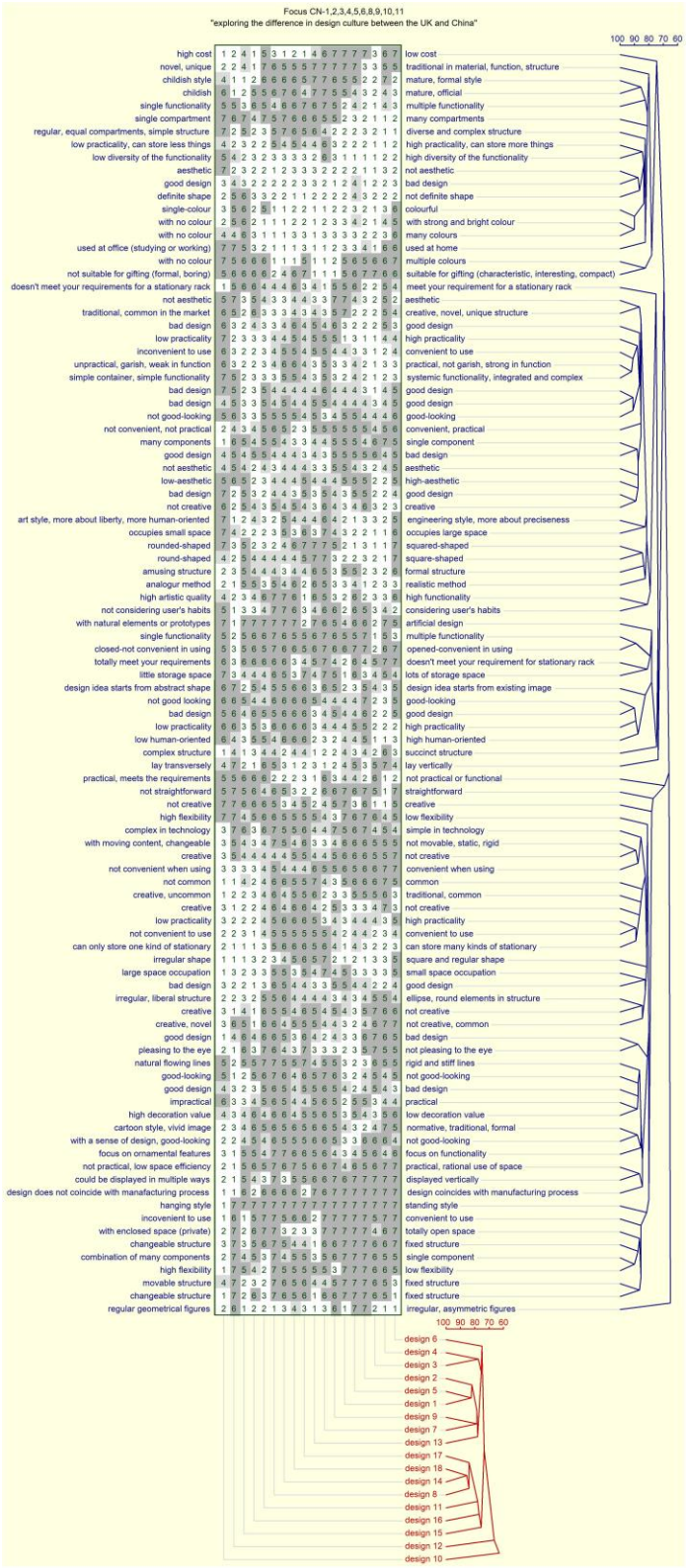
Appendix 4C: Cluster analysis graph of the UK general public group



Appendix 4D: Cluster analysis graph of the UK qualified designer group



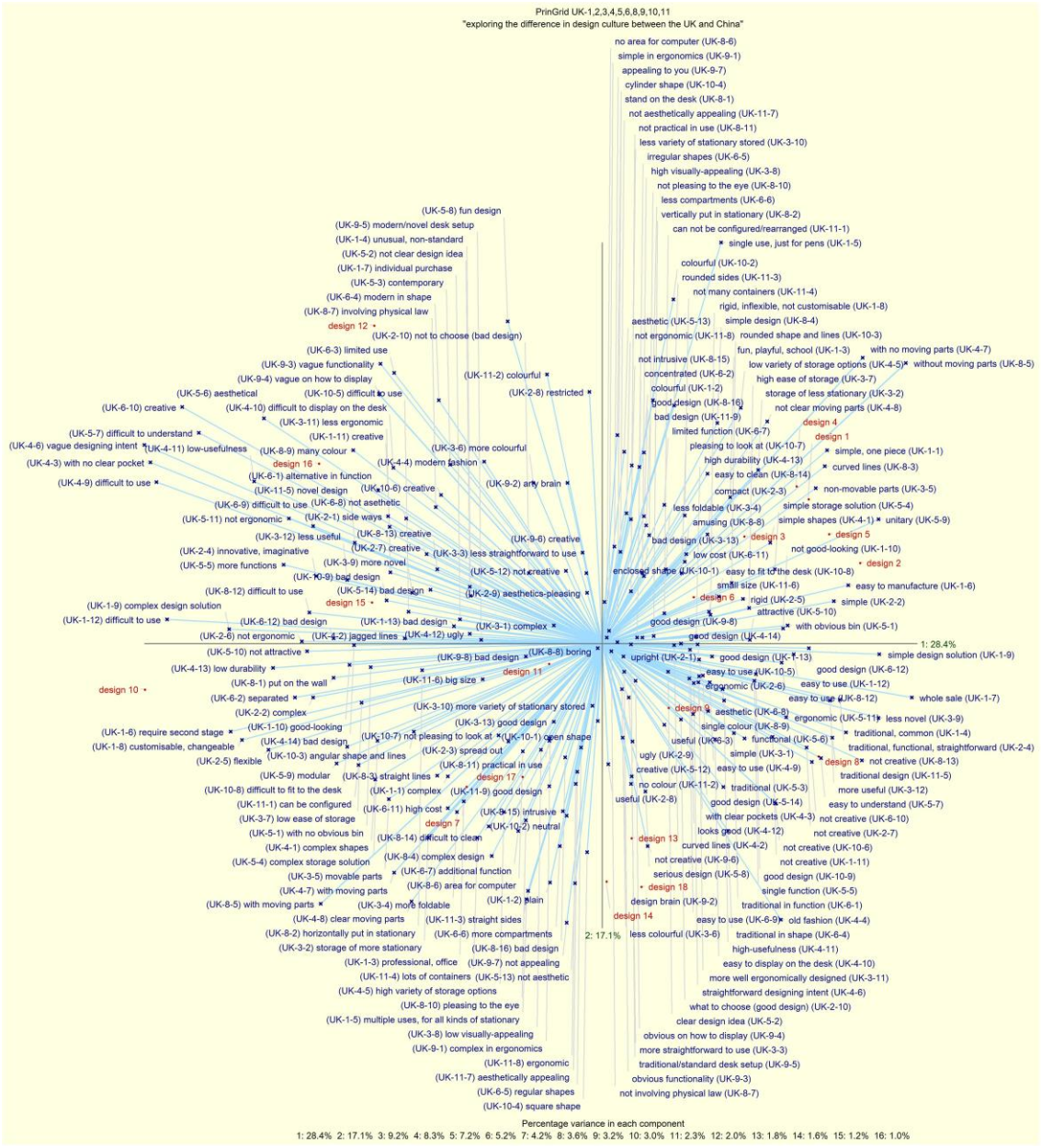
Appendix 4E: Cluster analysis graph of the Chinese general public group



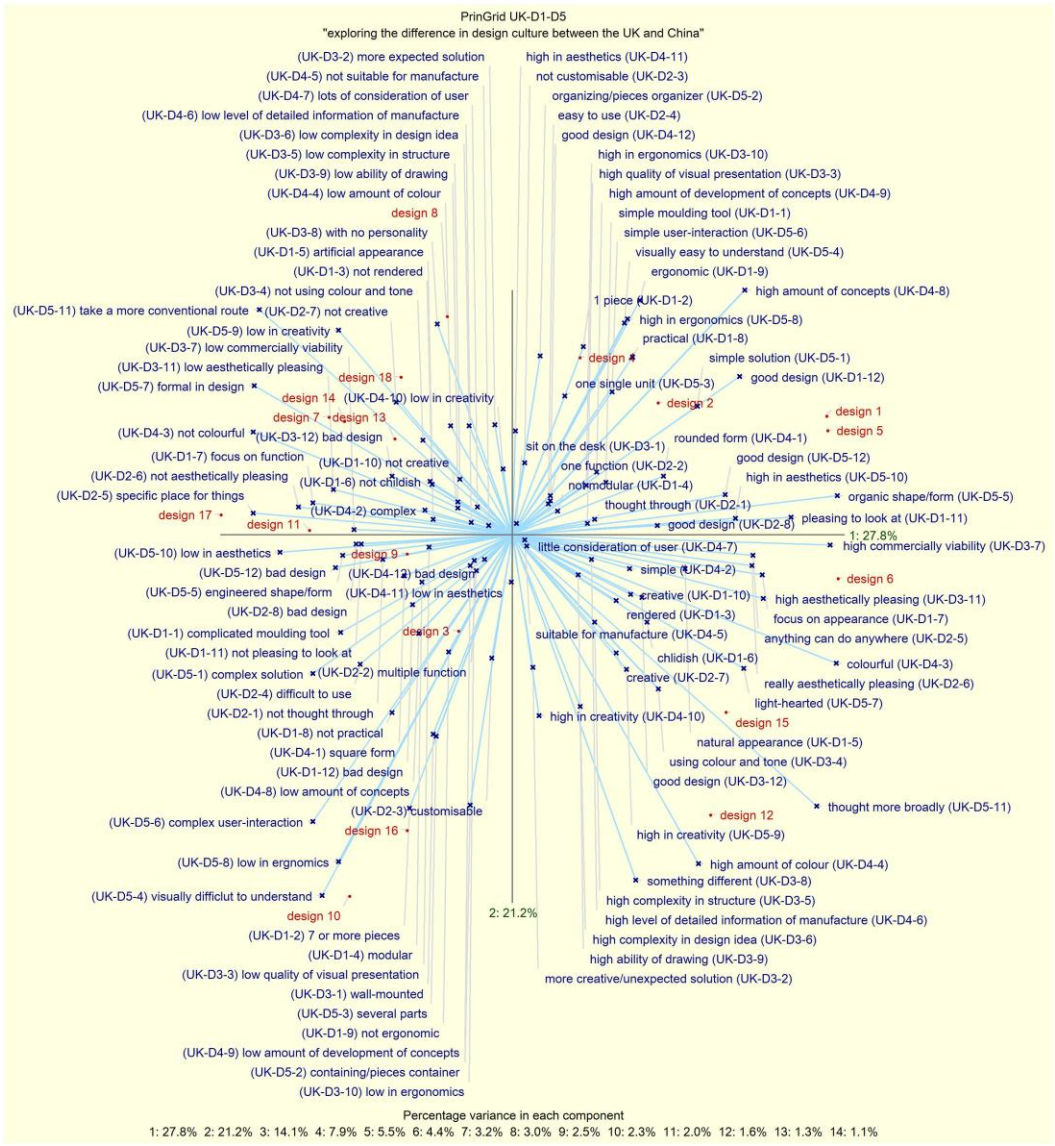
Appendix 4F: Cluster analysis graph of the Chinese qualified designer group



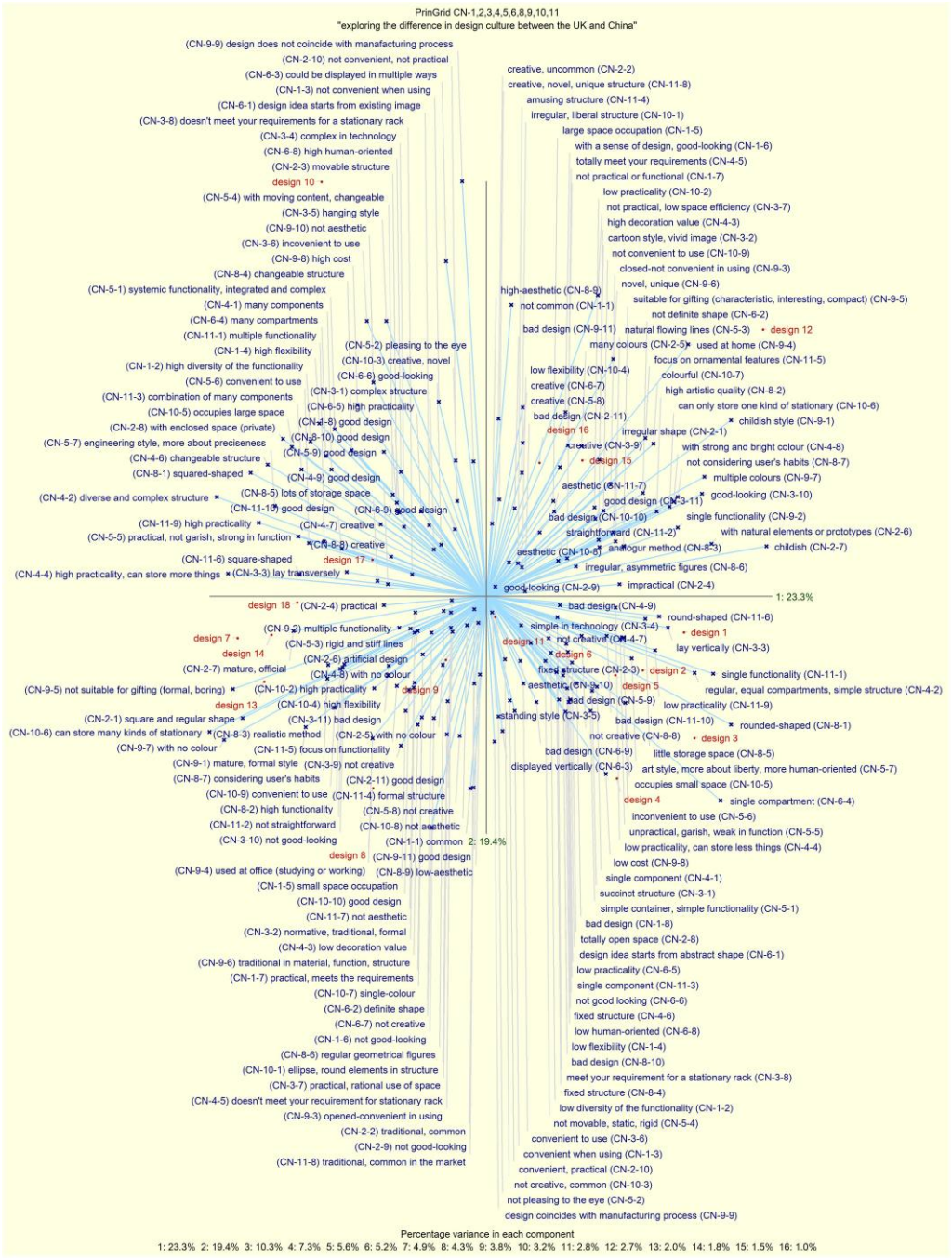
Appendix 4G: PCA graph of the UK general public group



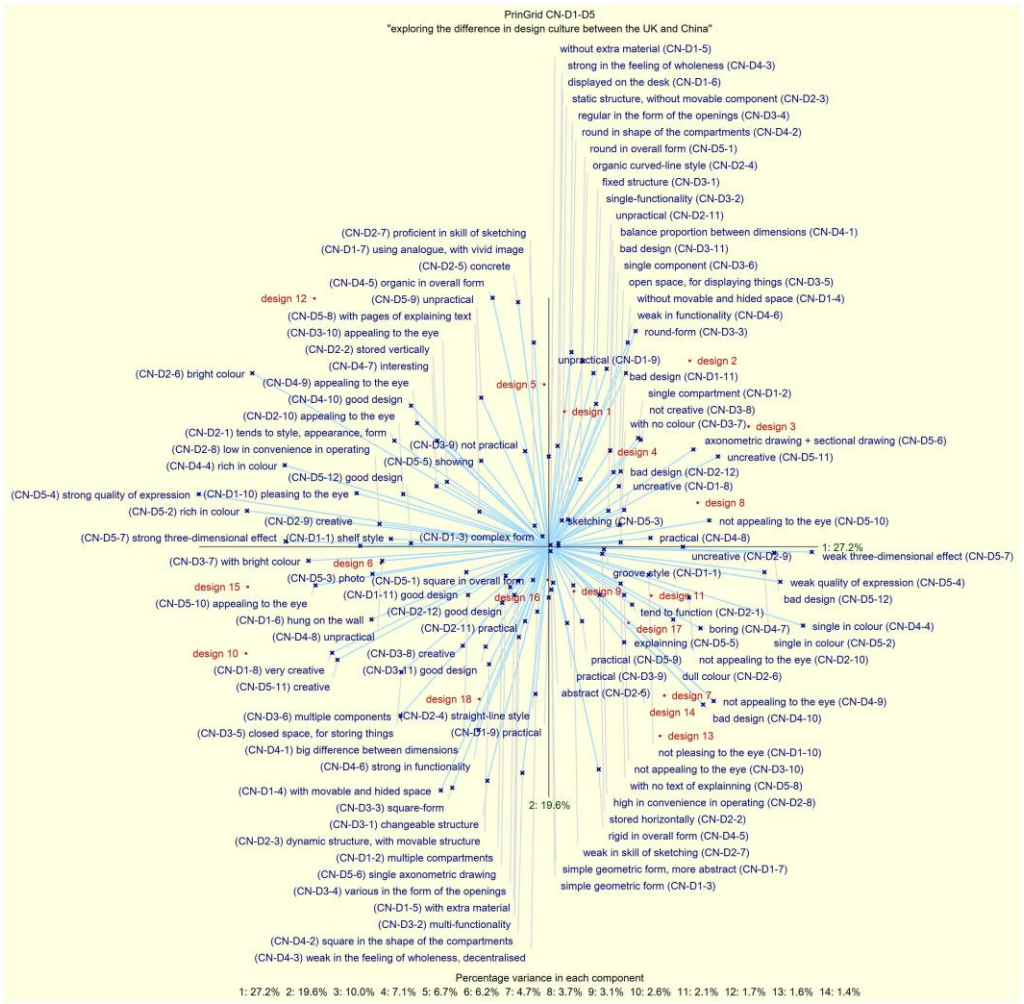
Appendix 4H: PCA graph of the UK qualified designer group



Appendix 4I: PCA graph of the Chinese general public group



Appendix 4J: PCA graph of the Chinese qualified designer group



Appendix 5A: Participant information sheets and consent forms of Study 2

Participant information sheet and consent form

Thank you for participating in my study.

Introduction of the study

This study is part of a PhD programme from the Human Factor Research Group of the University of Nottingham that aims at investigating cultural differences in product design between the UK and China. The study is about evaluating some daily-use product designs based on your own experience. With this study we want to find out about the differences in judgements of product design between British and Chinese people.

Your participation in this study

We want to get as broad a view as possible about the judgements on products designs from the **British general public**. You were originally chosen to participant in this study as we wanted to collect information from a wide range of people from different communities. Your do not have to take part in the study, but if you do it will be of great help to us.

We would like you to fill out a questionnaire which comprises two parts. The first part is about demographic information. The second part is questions about your judgement of some daily-use products. There are no “right” or “wrong” answers and the questionnaire should take about 15 minutes to complete.

Benefits of this study

You will be contributing to knowledge about cultural differences in judgement of product designs. In addition, you will be entered into a prize draw for five x £20 love2shop gift vouchers (we anticipate that 100 participants will participate in the study). The prize draw will be conducted after the finish of data collection. Winners will receive the gift voucher by post.

Privacy and confidentiality

Your responses will be kept completely confidential. We will not know your IP address when you respond to the Internet survey. You do not have to give your name in the questionnaire. Email addresses will be collected only for the prize draw. All data will be treated anonymously and will be stored on a password-protected computer and deleted 7 years after any publication arising from the work. Data will only be accessible by people directly involved in the research.

Contact information

If you have concerns or questions about this study, please contact Fangyan Tang at Fangyan.tang@nottingham.ac.uk or Supervisor Dr Glyn Lawson at glyn.lawson@nottingham.ac.uk .

Please print a copy of this information sheet and consent form for your records, if you so desire.

I have read and understand the above information sheet and consent form, I certify that I am 18 years old or older **British Citizen** and, by clicking the submit button to enter the survey, I indicate my willingness voluntarily take part in the study.

Appendix 6A: Participant information sheets and consent forms of Study 3

A longitudinal study of investigation of design work from British, Chinese and '2+2' students majored in Product Design and Manufacture

Participant information sheet

Thank you for participating in my study.

Introduction to the study

This study is part of a PhD programme that aims at investigating cultural differences in product design between the UK and China. This study will collect the design work from students majored in Product Design and Manufacture (PDM) and analyse them in detail to see if there were any differences in the design process between different groups of participants.

This study aims tat investigating cultural influence on the development of the design process of students majored in PDM. From the academic years of 2014/15, there will be about four design projects taken by the students in PDM both in the UK and the Ningbo campus. This study will take the students' design work from the four design projects and analyse them in detail based on the framework that is developed based on a literature review of design studies.

Your participation in this study

Your participation is voluntary. If you do decide to take part you will be given this information sheet and be asked to sign a consent form. You can withdraw at any time without affecting you or your academic performance in any way. You do not have to give a reason why.

We need you to authorize us to study your future design work in four design projects that will take place during the academic year 2014 to 2015. At the beginning, you have to complete a questionnaire on demographic information to make sure your background fits to this study. Then your design work will be collected at the end of each design project and be analysed. You will have no involvement in this stage – we just need your permission to use your work. We will also collect the tutors' ratings and grades on the relevant design work as references.

Privacy and confidentiality

Your design work will be photographed and stored electronically. Your work will be anonymized, i.e. no personal details relating to you nor what your scores are for this module, will be recorded anywhere. The material and the results of this study will be used only for the purpose of research. All data will be anonymised and will be stored on

a password-protected computer and deleted 7 years after any publication arising from the work. Data will only be accessible by people directly involved in the research. No images will be used without the participants' permission.

No personal information will be associated with the work and it will not be possible to identify any individuals from data. You will be allocated a participant number and this will be used to identify the designer's demographic information.

Thank you for taking the time to read this. If you have any question please do not hesitate to ask. Your participation in this study is very much appreciated.

Contact information

If you have any questions or concerns about the study, please contact:

Fangyan Tang
PhD Student in Human Factors
Human Factors Research Group
Faculty of Engineering
University of Nottingham
NG7 2RD
fangyan.tang@nottingham.ac.uk

Dr Glyn Lawson
Lecturer in Product Design and Manufacture
Human Factors Research Group
Faculty of Engineering
University of Nottingham
NG7 2RD
Glyn.Lawson@nottingham.ac.uk

Longitudinal study of investigation of design work from British, Chinese and '2+2' students majored in Product Design and Manufacture

Consent Form

- I confirm that I have read and understood the information sheet for the above study which I may keep for my records and have had the opportunity to ask any initial questions.

- I agree to take part in the above study and am willing to allow my design work to be stored and studied as described above.

- I understand that my information will be held and used for the following purposes:
  - Investigation into the difference of design culture between the UK and China
  - Dissemination of findings through academic publications

- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without being penalized or disadvantaged in any way.

On the basis of the information provided I am happy to participate.

Student Number …….

Name (please print) ……

Signed ……

Date ……

Appendix 7A: Participant information sheets and consent forms of Study 4

Study on British and Chinese designers from the design industry

Participant information sheet

Thank you for participating in my study.

Study introduction

This study is part of a PhD programme that investigates the cultural differences in product design between the UK and China. The PhD program aims to examine the cultural differences in product design from the perspectives of the design process and the final designs. For the previous studies, the subjects were mainly focused on student designers. This study aims to validate the results from previous studies on practitioner designers from the design industry.

Your participation in this study

At the beginning of the study, you will fill in a short demographic questionnaire which is mainly about your education background and work experience.

The formal study comprises of two main parts. In the first part, you will be given a design task and asked to develop design solution(s) within 1.5 hours; then in the second part, you will be asked to describe the design process and answer questions that are based on the design process. The whole process will be no longer than 2 hours.

This study is voluntary and you can withdraw from the study at any time without having to provide a reason. If you do withdraw, any information that has been collected from you will be destroyed and will not be included in the study. You do not have to answer any particular question.

Benefits of this study

You will be contributing to the knowledge about cultural differences in the product design process between British and Chinese designers. You will also get £20 worth of love2shop voucher as a reward for your time and your kind help.

Privacy and confidentiality

You will be coded with a participant number at the beginning of the study and it will be used throughout the implementation of the study. The process will be video recorded, while the shooting area of the camera will not involve the face of the participant.

All information collected from you will be stored in a locked filing cabinet at the University of Nottingham and destroyed seven years after any publication arising from the work in accordance with the university data storage policy. Your name (i.e. signature on consent form) will be kept separate from your questionnaire responses. Your

responses in the test will be made anonymous for publication in academic papers and in the thesis.

Electronic data will be kept on a password protected computer, for the duration mentioned above.

The information collected will be used for Fangyan Tang's PhD thesis and for academic publications and conferences.

This study has been reviewed and approved by The University of Nottingham Faculty of Engineering Research Ethics Committee.

Contact information

If you have any questions or concerns about the study, please contact:

Fangyan Tang
PhD Student in Human Factors
Human Factors Research Group
Faculty of Engineering
University of Nottingham
NG7 2RD
fangyan.tang@nottingham.ac.uk

Dr Glyn Lawson
Lecturer in Product Design and Manufacture
Human Factors Research Group
Faculty of Engineering
University of Nottingham
NG7 2RD
Glyn.Lawson@nottingham.ac.uk

Study on British and Chinese designers from design industry

Consent Form

- I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
- I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason.
- I understand that my information will be used by researchers involved in the project for a PhD thesis, academic publications and conferences. I understand that my data will be anonymised.
- I understand that the information will be kept in a locked filing cabinet and a password protected computer at the University of Nottingham; and the information will be destroyed seven years after any publication arising from the work in accordance with the university data storage policy.

On the basis of the information provided I am happy to participate.

Name ……..

Signature ……

Date ……

Appendix 7B: Summary of the content of the design sketches from the design process from two groups

Subject	Total No of sketches	Design concept	Inspirations	No of sketches	Main content of the sketches	Levels of sketches	sketch type
UK1	28	C 1	People in wheelchair would have problem with this? So make it two layers.	16	2 positions of the surfaces	2	1
					1 top view	2	2
					1 3/4 front view	2	2
					8 shapes of the surface	1	1
					4 details of parts: smooth surface, decoration, spice containers	1	1
		C 2	Don't want counter top everywhere	2	1 side view	2	1
					1 3/4 front view	2	1
		C3 -1	Build a wall to separate the loo	2	1 top view	2	1
					1 3/4 front view	2	1
		C 3 -2	Make it two layers	3	1 top view	1	1
					1 3/4 front view	2	1
					1 section view of sugar container	2	1
		C 4	From C2 & the consideration of association between stores	5	1 side view	2	2
					1 3/4 view with details of installing	2	2
					1 front view	2	2
					1 brief drawing of arrangement of shelves	1	1
					1 final design	3	2
UK2	22	C1	Make it vertical to free up access	8	3 working with the layout	1	1
					1 3/4 front view with details of installing	1	1
					1 top view	1	1
					3 different shapes	1	1
		C1-1	Modifying the idea of rotating	1	1 detail of how it rotates	2	1
		C2	Access from both sides	2	1 top view	1	1
					1 3/4 front view	1	1
		C3	Direct copy from internet	1	1 3/4 front view	2	1
		C4	Apply different styles	2	1 Bespoke Leg decoration	2	1
					1 Art decoration	1	1
		C5	Hygiene aspects (from a news about Starbucks)	2	1 indicating possible corner for germs	1	1
					1 no split line	1	1
		C6	Splits the furniture up into small units rather than one	6	1 smaller separate pieces	2	1
					3 different arrangements	2	1

			big piece, modular, easy to clean		2 shapes of the tray	1	1
UK3	17	C1	Existing thing, make it less boxy	3	1 3/4 front view	2	1
					1 side view	1	1
					1 front view + legs	2	2
		C1-1	Try to round it	1	1 3/4 front view	2	1
		C2	Inspired by the pillars in the stores	1	1 front view	2	1
		C2-1	Use intersecting planes to make things look uncomfortable	12	1 front view	2	1
					3 top views	1	1
					2 (1 front view, 1 side view) triangle shaped pillar	4	2
					2 (3/4 front view, 1 front view) square pillar	4	2
					1 side view with wall and a user figure	3	1
					3 details	1	1
UK4	20	C1	A round cylinder, to get people through quickly	1	1 3/4 front view	1	1
		C2	facing two ways, two points of access, offering the fluency	19	3 top views, adjusting the shape	1	1
					2 3/4 front view with different shapes and different design of the top part	2	1
					1 detail design about the installing	1	1
					2 top view with different angles	1	1
					1 3/4 front view with different detail design	2	1
					1 3/4 front view	2	1
					4 different form of the fence design for the top layer	2	1
					4 components and inside contracture	1	2
					1 final design: 3/4 front perspective drawing	4	2
UK5	13	C1	City-themed, imposing like a skyscraper	7	1 front view perspective drawing	2	1
					4 top view with changes of the shape	2	1
					1 front view perspective drawing with different shapes	2	1
					1 side view with a user figure and arrangement of items	2	1
		C2	try to make the whole thing	6	1 side view of the top part	2	1

			more flowing rather than square and edgy		1 top view of the top part with divisions for items	2	1
					1 3/4 front view perspective drawing	2	1
					2 top view: 1 with customer flow indication	1	1
					Final design: 1 3/4 front view perspective drawing	4	2
UK6	4	C1	Try to get local connection in the stores, so use local timber, to fit into stores in different locations	4	1 3/4 front view perspective drawing with indication of the heights for wheelchair users and normal people standing; with text of design rules	3	1
					1 user in wheelchair	1	1
					1 3/4 front view perspective, using heavily processed timber	4	2
					1 3/4 3/4 front view perspective , using simple technique and cheap timber	4	2
UK7	27	C1	A combination of metal work and a sign fabricated steel, Sheffield is famous for steel	4	1 top part design, picked from a image from the internet	3	1
					1 side view	2	1
					1 3/4 front view perspective drawing with different standing	3	1
					1 3/4 front view of top part, dealing with the installing details	1	1
		C2	Combine wood with steel	6	1 3/4 front view perspective drawing	3	1
					2 top view + 3/4 front view of the top part design	3	1
					1 front view	3	1
					1 side view with changes in the angle of the work surface	3	1
					1 another thought for the stanchion	3	1
		C2-1	picked an element from Sheffield Winter garden	3	1 3/4 front view perspective	3	1
					1 front view with angle of the surface	3	2
					1 side view with angle of the surface	3	2
		C2-2	looking at ways to increase the surface area to accommodate all the given items	14	3 top view of the surface, increasing the numbers	2	1
					1 side view with a user figure	2	1
					1 side view with three surfaces	2	1

					3 side of the design of the stanchion	2	1
					1 3/4 front view perspective drawing	3	1
					1 bin	1	2
					1 with the Starbucks logo on the top part	1	2
					2 final design: 2 side views: 1 with a user figure; 1 layout map of the store with the design	3	2
UK8	11	C1	Reflecting the surrounding neighbourhood, council building of Nottingham	11	1 3/4 front view perspective drawing	1	1
					1 front view of the community notice board	1	1
					1 arrangement of the given items	2	1
					3 3/4 front view of the base, different arrangements of the bins	3	1
					1 front view of the top part, to make it more local with images of the city council	2	1
					1 front view, placing the bin at the left end	2	1
					2 top view + front view of the working surface	2	1
					1 final design 3/4 front view perspective drawing	4	2
UK9	19	C1	The key elements you need, a big flat surface	10	2 3/4 front view + side view with a user figure	2	1
					5 items and containers would be placed on the shelf	2	1
					1 reclaimed wood surface	2	1
					2 3/4 front view with different positions for the bin	1	1
		C1-1	to have access from two sides	9	1 front view, duplicate everything twice of C1	2	1
					1front view, rotate the shape to access from two sides	2	1
					3 front view, change the shape, narrow down at one end, with different top part design	2	1
					3 top view of different top part design	2	1
					1 final design, 3/4 front view perspective drawing, with components	2	2

UK10	5	C1	a common cabinet, a common layout, customisation	5	1 layout of the given items	1	1
					1 front view with graphics for localization	1	1
					1 3/4 front view	2	2
					2 final design: 1 3/4 perspective drawing, 1 condiment boxes	4	2
CN1	3	C1	To make it as functional as I can, very practical, to address the requirements as much as possible	3	1 front view with text to indicate the different areas in the counter	1	2
					1 front view + 1 top view with doors and drawers	2	2
					1 front view + 1 top view with more open area	2	2
CN2	23	C1	As a table	2	1 top view	1	1
					1 front view	1	1
		C2	As a shelf	21	2 different shapes	2	1
					6 different shapes and styles of the fence for the top layer	1	1
					2 (1 front view + 1 top view) considering the ergonomics	2	1
					6 about the 2nd layer, about the containers for the napkins and other stuff	1	1
					4 for bottom layer and other functions	1	1
					1 final design	2	2
CN3	9	C1	A box shape and divided the surface in the shape of the Chinese character of Yong (Ningbo)	9	1 3/4 side view of a box	1	1
					1 top view of division	1	1
					1 top view of detailed division	1	2
					2 3/4 view with decoration	2	2
					4 final design: front view, top view, 3/4 front view, perspective drawing	2	2
CN4	9	C1	The toilet, to separate it, using the L shape and the idea of Chinese style of screen	9	2 top view of the L shape and the sections on the work surface	1	1
					1 3/4 front view	1	2
					4 different styles of the screen	1	1
					2 different styles of the screen with text indication	2	2
CN5	5	C1	Chinese style	5	1 about the top part of the shelf	2	2
					1 3/4 front view with the top pat as a standing counter	2	2
					1 changed the top part	2	2

					as a layer of shelf		
					2 final design: 3/4 front view + top view	3	2
CN6	11	C1	Containers	11	5 about a Starbucks using the element of containers	2	1
					2 3/4 front top/ front bottom view	2	1
					1 side view	2	1
					1 front view	2	2
					1 about the surface decoration	2	2
					1 final design	4	2
CN7	14	C1	Inspired by the corner part of Tian Yi Square	14	5 top view of different shapes	1	1
					3 3/4 front view with different shapes and surface decoration	2	1
					1 detailed design of the top part	2	1
					1 top view	1	1
					2 section view of parts,	2	2
					1 3/4 front view, perspective drawing	3	2
					1 final design: 1 front view, perspective drawing;	3	2
CN8	24	C1	Deduction on the size	3	1 common design	1	1
					1 3/4 front view of two connected boxes	1	1
					1 3/4 front view of two boxes with one of deducted size	2	1
		C2	As a table, to make it easier to clean the ground	12	3 ways of the counter, evolved into a table	1	1
					1 3/4 front view with labelled surface	2	2
					5 presentation board plans	2	2
					1 final design	3	2
					1 side view with size	2	2
					1 about size with a user figure	2	2
		C3	Different arrangement of small boxes, inspired by the using of A4 paper (used to measure the sizes), made into a modular system to fit to different stores	9	1 3 different arrangements of boxes with a user figure	2	1
					5 presentation board plans	1	2
					1 final design	3	2
					1 front view	1	2
					1 with size and dimensions, with a user figure	2	2
CN9	8	C1	with curve lines, use Starbucks's normal style, business style	8	1 top view with area division	1	1
					1 3/4 front view	1	1
					3 top view with different shapes	1	1

			coffee		1 3/4 front view	2	1
					1 3/4 front view	2	2
					1 final design	3	2
CN10	13	C1	Assumed the store located in Gu Lou, so a Chinese style design, also to fit to the Starbucks style and all the requirements in functions	9	3 front view with differences in details	2	1
					1 top view to arrange the items	2	1
					1 3/4 perspective drawing	3	1
					1 Chinese style pot design	1	1
					1 front view with arrangement of the items	2	2
					2 final design: 1 3/4 perspective drawing, 1 front view	3	2
		C2	From the round-backed armchair of Ming style furniture, trying to do an American style	4	1 3/4 front view with a top in the shape of round-backed armchair of Ming style	1	1
					1 curve lines	1	1
					1 one piece design	2	1
					1 3/4 front view with wooden texture and element of butterfly	2	1

Appendix 7C: Answers to the question of "what is the purpose of information research in your design process?"

Participant	"What is the purpose of information research in your design process?"
UK1	To inform what I'm doing and what I'm designing, so that you don't just design a * and not designing something that is completely a waste time and space. To help you meet the brief for the client.
UK2	...gather images or take inspirations from the internet…to keep myself in tune with everybody what's going on and be inspired.
UK3	They were mainly about understanding the environment, the part it was going to be in...To see if it's suitable for the environment.
UK4	I'm drawing on my experience. If you ask me to design for some brand I never heard of, I might need to do more research. Because it's familiar, I already got views. I'm going off my knowledge rather than research things.
UK5	It's quite important because it helps you understand the brief. To understand what the client wants to see.
UK6	I think that comes back down to understand the client and make sure that you are answering the right question.
UK7	...it's visual material... I didn't go looking for … the visual material was a big inspiration for sorts, but I didn't choose to look for any statistics or historical information about the city, which I like to know had I not been familiar with city. But my research was really visual. Again it's because of the time, you have to begin quickly.
UK8	It was finding out the requirements that they wanted, like the bins and also seeing their use on recyclability. They say that they have there dry recycle and food recycle, so that was quite a big factor I have used like two different shapes bins.
UK9	Basically for getting ideas, getting inspirations, things like materials they use. Basically to get some images of the inside of the shop, so that I could think how to integrate it with anything else in the shop.
UK10	(You titled it as market research?) Yes, that's a bit … overstating what I did. That was just a quick and dirty… and just look what was it.
CN1	For me, designers must give people the right thing, but no something that you think is good-looking, or cool, not fit to people's needs. Especially for these commercial occasions, I think it's important to give the right product.
CN2	First of all, I need to know what a condiment counter is like generally. And then the condiment counter in Starbucks… The environment. The existing products and the using environment. Another one is for things that I don't know, like I need to know the size and shape. It is like market research.
CN3	It is where all the inspirations come from, the tone of Starbucks and Ningbo city.

CN4	Normally, it's for investigating the existing products. There is quite a common phenomenon like a thinking crash, which means that when you think of something actually someone else also have thought about it and already designed the product. So in real project, we need to avoid this. And also for searching materials…. Normally we would learn from some existing design directly due to the short design period, instead of finding inspirations from some basic elements.
CN5	It's more for inspiration or experience. Because there must be some people that have more experience in some specific area, you would get more from them. But it also has its drawbacks, such as it would interrupt your creativity.
CN6	To set the main direction. First of all the style of Starbucks. To find some distinctive stores of SB and then combine it with some features of Ningbo city, and together with these two aspects there came the main direction of my design. It is the narrow down step after the brain storming.
CN7	The location I searched determined the shape of my design... The environment also determined the materials and the shape.
CN8	I think it's very important, although I think the best way is do some field trip, it could get more information. It is to determine the fundamental key, the main direction.
CN9	It determined the main direction (what product, the user, competitor, etc.). It's not only about the online search.
CN10	Leading role. All the follow-up things need to be based on the research, like the style. To know what the design is about, what has been designed. After I determined the style, I searched for images and these images could inspired me to some extent. At the early stage, my searching for images were quite blind.