A study of context-based multi-sensory user experience

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**A STUDY OF CONTEXT-BASED MULTI-SENSORY
USER EXPERIENCE**

CHEN NAI-FENG

SCHOOL OF MECHANICAL AND AEROSPACE ENGINEERING

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**A STUDY OF CONTEXT-BASED
MULTI-SENSORY USER EXPERIENCE**

CHEN N.F.

CHEN NAI-FENG

School of Mechanical and Aerospace Engineering

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Abstract

In recent years, the paradigm of product design and development (PDD) has been shifted from addressing functional and technological issues to more user-centred and consumer-oriented concerns. The experiential aspect of design has taken a crucial role in creating more consumer-focused products. Oftentimes, customer research or user involvement studies are conducted to acquire necessary knowledge and gain an insight into user experience. Unlike functional requirements, experiential customer requirements are usually more tacit, latent and complex. As such, the issues concerning user experience acquisition in consumer goods design deserve more attention.

To address the inherent characteristics of an experience being complex, subjective and dynamic, an integrated design strategy – ‘designing for multi-sensory experience from a contextual level’ is applied. Accordingly, a prototype User Experience Cycle (UXC) is proposed in this work to better present and depict the iterative process of user experience. A prototype Context-based Multi-Sensory Experience System (CMSES) with a Scenario Co-built Strategy (SCS) is established to guide the user involvement and help designers tackle diverse contextual factors considering individual differences. By using the approach, designers and users can together co-build more customized usage contexts which allow users to experience and evaluate a product under more realistic situations. In addition, a User-Context Form (UCF) is developed to help designers manage complex and diverse data, such as user background information and their ideal usage contexts. It can also facilitate the communication within stakeholders.

Two case studies, namely a biscuit container design and an automated teller machine (ATM) design, are conducted to illustrate the capability of the proposed approaches and demonstrate how designers can gain an in-depth and more comprehensive understanding about user experience. The results suggest there are individual differences in personal ideal usage scenarios, which, along with contextual factors, can influence user experience and evaluation. Designers should thus not neglect such inherent characteristics of an experience, but consider them carefully at the very beginning while planning a user involvement study. As illustrated in the case studies, it appears that the proposed approaches are promising and may help designers examine, explore and investigate user experience in a dedicated and robust manner and, hence, strengthen the context-based multi-sensory experience exploration and design.

Keywords: Consumer-oriented design, Context-based design, Industrial design, Scenario, Usage context, User experience, User-centred design

List of Publications

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Chen, C.-H., Yan, W., & **Chen, N.-F.** (2012, September 3–7). *Consumer-oriented Product Conceptualization via a Web-based Data Mining Approach*. In Proc. of the 19th ISPE International Conference on Concurrent Engineering (CE 2012), Vol. 2, pp. 945-956, Trier, Germany.

Chen, C.-H., **Chen, N.-F.**, & Yan, W. (2011, November 11-12). *Sustainable Product Conceptualization for Green Cars*. In Proc. of the 2011 KSID (Korea Society of Industrial Design) Congress, pp. 65-74, Seoul, South Korea.

Chen, N.-F., Ho, C.-H., & Ma, M.-Y. (2011, June 22–25). *Sensory importance and emotions at early stage of product experiences – A qualitative study of juice squeezer*. Paper presented at the 5th Conference on Designing Pleasurable Products and Interfaces, Milan, Italy.

Chen, N.-F., Wu, F.-G., & Ho, C.-H. (2010, July 17–20). *Tactile Buttons Used in Non-Visual Cell Phone*. Paper presented at the 3rd International Conference on Applied Human Factors and Ergonomics, Miami, Florida, USA.

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List of Abbreviations

CE	Concurrent Engineering
CMSES	Context-based Multi-Sensory Experience System
CPD	Collaborative Product Development
HCI	Human–Computer Interaction
NPD	New Product Development
PDD	Product Design and Development
PLC	Product Life Cycle
SCS	Scenario Co-build Strategy
UCF	User Context Form
UX	User Experience
UXC	User Experience Cycle
VOC	Voice of Customers

Chapter 1 Introduction

This chapter introduces the background of the research and discusses the research gaps which lead to the research objectives and scope.

1.1 Background

Customers and users are the focus

Knowledge about customers has attracted much attention from diverse stakeholders engaged in product design and development (PDD). As noted by Terwiesch and Ulrich (2009), about a quarter of innovation opportunities across all industries are derived from interactions with customers. The paradigm of the PDD process, apart from addressing functional and technological issues, has shifted to user-centred and consumer-oriented concerns (Chen, et al., 2009; Nagamachi, 2002; Sanders, 1999) in the last few decades. Accordingly, the ability to understand and grasp the rapidly-evolving customer requirements has become an essential yet challenging issue that most companies need to address. Furthermore, Ulrich and Eppinger (2012) pointed out how imperative it is for companies to interact with customers and gather data on the use environment of the product in order to facilitate the discovery of new innovative solutions that fulfil the deeper needs of customers. In recent years, an increasing number of designers are devoting significant efforts to conduct user involvement studies and user experience research.

The essence of user experience

When examining user experience, an important issue that designers are faced with is the inherently complex, subjective and dynamic nature of user

experience given numerous personal and contextual factors (Buchenau & Suri, 2000; Zomerdijsk & Voss, 2011). The diverse characteristics and aspects of user experience are organized and represented in Figure 1-1.

Figure 1-1. The diverse aspects of user experience¹; (adapted from Chen, et al., 2015b)

¹ The numbers (from 1 to 12) represent the citations as follow:

(1) Buchenau & Suri, 2000; (2) Hekkert, 2006; (3) Huang, et al., 2012a, 2012b; Khalid & Helander, 2006; Norman, 2004; (4) Bloch, 2011; Lindstrom, 2005; Schifferstein & Cleiren, 2005; Schifferstein & Spence, 2008; Spence, 2011; (5) Buchenau & Suri, 2000; Pine & Gilmore, 1998; Rodrigues, et al., 2011; (6) Buchenau & Suri, 2000; Law, et al., 2009; (7) Schifferstein & Desmet, 2007; (8) Chen, et al., 2011; Fenko, et al., 2010; (9) Holmes, et al., 2007; (10) Chen, et al., 2012; (11) Chen, et al., 2011; Fenko, et al., 2010; (12) Chen, et al., 2012.

User experience is complex

First, user experience is a complex subject matter to be examined from various levels. Hekkert (2006) highlights three levels in user experience, namely aesthetic, understanding and emotional. The aesthetic experience is understood as the pleasure that results from sensory perception. The other two levels are more closely connected to the human mind, i.e., cognition and emotion. As the three levels are highly interrelated and intertwined, what users actually experience is the amalgamation of these different levels. Based on this understanding, Hekkert (2006) defined users' product experience as:

“the entire set of effects that is elicited by the interaction between a user and a product, including the degree to which all our senses are gratified (aesthetic experience), the meanings we attach to the product (experience of meaning), and the feelings and emotions that are elicited (emotional experience).”

The three levels can also be understood as representing the sensory, cognitive and affective aspects of user experience (Chen, et al., 2015b). On the sensory aspect, many researchers have carried out investigations into multi-sensory experiences, as all five senses are involved or contribute to a user-product interaction (Chen, et al., 2011; Schifferstein & Spence, 2008; Spence, 2011).

User experience is subjective

Second, an experience is subjective in that it is strongly influenced by one's previous experiences and background. As suggested by Pine and Gilmore (1998), an experience is inherently personal, existing only in the mind of an individual who has been engaged on an emotional, physical, intellectual, or

even spiritual level. Accordingly, it is important to treat users in a more personal manner (Rodrigues, et al., 2011) due to the strong individual differences that result from multiple factors like cultural background, lifestyle, personal habits and preferences. Of the three aspects of user experience, the affective part is considered to be the most subjective as each individual feels the world and appreciates things in a unique way (Lee, et al., 2002). Products that seek to satisfy the average customer requirements through only having a market-focused design are no longer sufficient. Rather, customer-focused products that incorporate a larger degree of individuality are fast gaining popularity in highly competitive markets (Jiao & Chen, 2006; Tseng & Piller, 2003).

User experience is dynamic

In addition to being complex and subjective, the third characteristics of user experience is that of being dynamic and context-dependent (Buchenau & Suri, 2000; Law, et al., 2009). The broad notion of context refers to all factors that influence the experience of product use (Visser, et al., 2005). For example, 'time' is a representative factor which may influence user experience, such as multi-sensory experiences (Chen, et al., 2011; Fenko, et al., 2010), as well as the evaluation criteria, such as determining the dominant criteria for evaluating goodness (Karapanos, et al., 2008). Thus, designers need to deal with moving goals (Taylor, et al., 1999). Other contextual factors can include space, people, objects and external factors. To better address the issue, Stappers et al. (2009) proposed starting from the contextual level, continuing through the user-product interaction level, and then moving to the product level.

Design strategies

Clearly it is important to take the inherent characteristics of user experience into consideration when conducting user involvement studies. Designers therefore have to consider end-users with diverse abilities from different segments under all possible situations in order to gather more realistic and comprehensive knowledge that facilitate consumer-oriented design. In this realm, some design strategies, such as the following, can be applied properly.

➤ Designing for experience

First of all, what matters is not the product or technology itself, but the experience it creates and the story it tells users (Hassenzahl, 2011). The competition today depends heavily on ‘customer experience’ (Pine & Gilmore, 1998) and ‘experience design’ (Stappers, et al., 2009), especially when design has become more and more complex. For example, consumers’ long-term satisfaction tends to decrease for material purchases but increase for the experiential ones (Boven & Gilovich, 2003; Gilovich, 2010). This implies that in order to create a product offering with more long-lasting fulfilment, designers should apply a strategy utilizing ‘experience design’ or ‘design for experience’.

➤ Designing for emotions

A well-known design philosophy ‘form follows function’ has shifted to ‘form follows emotions’ (Esslinger, 1999). In fact, the emotional aspect of experience has attracted significant attention from scholars and enterprise in recent years as more and more researchers advocate a greater emphasis on the value of emotional design (Huang, et al., 2012b; Norman, 2004), affective

design (Chen, et al., 2006; Khalid & Helander, 2006) and Kansei (*a Japanese word for sensory*) engineering (Huang, et al., 2012a; Lee, et al., 2002; Nagamachi, 1995).

➤ **Designing for multi-senses**

Everyday people explore the world through five senses. When interacting with a product, different senses all work together to create one's own experiences. Each sense plays a different role during each experience. Some senses pay more attention to functional operation (Schifferstein & Cleiren, 2005), while others evoke stronger emotions (Spence, 2002) and deeper memories (Herz & Schooler, 2002). All these sensory information gathered during the user product interaction contributes to the overall user experience (Schifferstein & Spence, 2008). It is more probable for a product to succeed if it can gratify more senses and consequently evoke more emotions (Schifferstein & Spence, 2008; Spence & Gallace, 2011; Vergara, et al., 2011). It is important for a designer to realize how senses work together and change their roles when a user interacting with a product. Taking senses into consideration can help designers to create a long-lasting product, which can satisfy consumer's multisensory experiences and create positive emotions (Lindstrom, 2005; Schifferstein & Spence, 2008). The method by which a product stimulates multiple senses can determine the product's final success. It is thus worthwhile to investigate end users' multi-sensory experience and to incorporate it into a strategy of designing for experience, i.e. design for senses (MacDonald, 2001) or multi-sensory design (Spence & Gallace, 2011).

➤ **Designing from a contextual level**

Since experience is a constructive activity (Sanders, 1999) and is quite context-dependent, failure to deal with the contextual factors may render the user experience or evaluation ecologically invalid (Jakesch, et al., 2011). In addition, it is advisable to avoid treating a pre-existing product as the starting point for design. Instead, designers are encouraged to redefine ‘a product’ as ‘a context for experience’ (Hummels, et al., 2001) and develop ideas from beginning at the ‘contextual level’, through to the ‘user-product interaction level’, and then to the ‘product level’ (Stappers, et al., 2009). With this approach, designers can undertake a better exploration of user experience, and reduce the risk of being limited by existing designs particularly when it comes to new product development (NPD).

Challenges and opportunities

In a nutshell, the main challenge is to deal with each of the inherent characteristics of user experience concurrently during user involvement studies. Despite this, current studies seldom deal these characteristics with more careful and thorough consideration during user experience studies. Practical studies too are lacking that would demonstrate how designers can examine and explore users’ multi-sensory experience in a more in-depth and comprehensive manner. To address this situation, this study suggests a strategy for ‘designing for multi-sensory experience from a contextual level’ as well as investigates the ‘context-based multi-sensory experience exploration and design’ aimed at helping designers obtain in-depth knowledge of the user experience that in turn facilitates such a design strategy.

Scenario technique as a tool

Conventionally, a scenario technique is often applied to deal with usage context settings. Because it has the power to describe the context in detail and illustrate users' behaviours and activities, it is widely used to strengthen user investigations, design conceptualizations, planning, and management (Carroll, 1999, 2000; Go & Carroll, 2004; Potts, 1995). Being a lightweight method without redundant rules, it can also be adjusted according to one's purpose and needs. In addition, it can be carried out through various mediums, including descriptions (textual narratives), sketches, storyboards, images, videos, and live performances (Go & Carroll, 2004; Rosson & Carroll, 2002; Suri & Marsh, 2000). Different applications of scenarios may focus on different viewpoints, hold different goals, and have different levels of details. Nevertheless, scenarios provide a common language for diverse stakeholders to access and share information with each other (Go & Carroll, 2004).

The insufficiency of current scenario techniques

Despite the fact that scenario techniques can effectively help designers manage usage contexts or multiple contextual factors, they seldom consider the subjective issues mentioned above. For example, the usage scenarios employed in a user involvement study are oftentimes decided by the design team according to generalised user group data, and then assigned to users. Hence, end users play a relatively passive role in their responses to scenarios. This approach fails to systematically take individual differences into more careful consideration. The extent which such fixed and assigned scenarios can really fit into the individual's world in numerously varied societies worldwide still remains a pressing issue (Chen, et al., 2012; Chen, et al., 2015a). This is crucial

given the high probability of the user experience being affected by the multiple contextual factors defined in a usage scenario. Consequently, the accuracy and completeness of user experience and evaluation data acquired in this manner would be considered less reliable with less certainty as it cannot closely link to users' real lives. One way to narrow this gap is for individual differences to be scrutinized from the very beginning of the process when working at the contextual level.

The representation of complex information

Another challenge designers face is the management of complex and diverse data with regard to user background and their ideal usage contexts. Such information management is important as it affects the value and benefits that can be derived from the acquired data. Sometimes the user information provided to the designers fail to match the designers' needs, and the former's usability is thus limited (Goodman, et al., 2007). One possible reason for this discrepancy lies in the fact that different knowledge users (e.g., researchers versus designers) have different knowledge needs and preferences given their distinct intentions and objectives. For designers, the ideal presentation of information is flexible, open-ended, and stimulating for easy absorption (e.g., with the use of graphics, video and scenarios) (Bruseberg & McDonagh-Philp, 2002; Dong, et al., 2015; Goodman et al., 2007; Lofthouse, 2006). They also prefer the information to be quick and easy to find and use. Design researchers should therefore consider designers' preferences when developing the tools designers require to investigate user experience, or when providing them with information on user background and usage contexts.

1.2 Research gaps, objectives and scope

Research gaps (or opportunities)

Previous research has pointed out the importance of customer input especially where it concerns the customer's experiential knowledge. In recent years, scholars have made substantial efforts in developing methods and tools in these research realms. As discussed, several design strategies can be applied and integrated together. However, in practice, there are several issues and gaps that have yet to be adequately addressed. The research gaps (or opportunities) are identified as follow.

1. A model that can better represent the overall user experience by incorporating its inherent three characteristics viz. complex, subjective and dynamic, has yet to be established.
2. The capability of the proposed concept – ‘context-based multi-sensory experience exploration and design’ and corresponding design strategy – ‘designing for multi-sensory experience from a contextual level’, which effectively integrates design strategies ‘designing for experience’, ‘designing for emotions’, ‘designing for multi-senses’ and ‘designing from a contextual level’, has yet to be examined.
3. A systematic approach to guide the PDD process when applying such design strategy has yet to be established.
4. Though conventional methods such as scenario techniques can help deal with multiple contextual factors or usage contexts during user

involvement studies, they fall short of considering individual differences in personal ideal/suitable usage contexts.

5. The extent to which multiple contextual factors or usage contexts affect user experience and the manner that they do have yet to be well explored.
6. The necessity and feasibility of providing users with more customized usage contexts in user involvement studies have yet to be examined, including the lack of an existing systematic approach to achieve this.
7. It remains a challenge to handle complex diverse data -- with regard to user background information and their ideal usage contexts -- in a manageable and designer-friendly way (e.g., one which is flexible, open-ended, easy comprehension, and easy to process).

Research objectives

Accordingly, the research objectives are listed as follows.

1. To gain a more in-depth and comprehensive understanding of user experience and its three characteristics, a prototype User Experience Cycle (UXC) is proposed that depicts and explains the user experience process. *(Corresponding to research gap point 1)*
2. To facilitate the 'context-based multi-sensory experience exploration and design' and its corresponding design strategy 'designing for multi-sensory experience from a contextual level', a prototype Context-based Multi-Sensory Experience System (CMSES) is established to guide the PDD process. *(Corresponding to research gap points 2 and 3)*
3. To reconcile the issues of individual user differences arising from multiple contextual factors or usage contexts during user involvement

studies, a Scenario Co-build Strategy (SCS) is proposed and demonstrated. (*Corresponding to research gap points 4 and 6*)

4. To better understand issues of user experience, the study attempts to demonstrate how designers can explore and examine user experience based on the proposed Context-based Multi-Sensory Experience System (CMSES) with a Scenario Co-build Strategy (SCS) – from preparation to execution and analysis stages. (*Corresponding to research gap points 2, 5 and 6*)
5. To help designers tackle the complex diverse data of user background information and multiple contextual factors while applying the SCS, a flexible and lightweight tool, viz. the User Context Form (UCF), is developed and illustrated. (*Corresponding to research gap point 7*)

Figure 1-2 further represents the relationship and links between the research background and the proposed approaches.

Figure 1-2. The relationship between research background and the proposed approaches

Research scope

Based on the research objectives, the scope of the work is described as follows.

1. ***A literature review.*** A literature review is undertaken to identify the research parameters. The review mainly focuses on the user experience and scenario technique related issues.
2. ***A model to depict user experience process.*** A UXC (User Experience Cycle) model is formed to represent the iterative user experience process, which considers inherent characteristics of user experience at the beginning when users first contact a product (under a specific context considering individual differences), then interact with it through all the senses, and conduct an overall evaluation of the user experience, followed by a decision-making. Finally, the resulting context-based experiential customer requirements can help designers create iterative designs.
3. ***An integrated design strategy.*** Based on current design trends, an integrated design strategy ‘designing for multi-sensory experience from a contextual level’ is proposed. Corresponding approaches are also developed to assist designers conducting the ‘context-based multi-sensory experience exploration and design’ during user involvement studies in PDD.
4. ***A systematic approach to guide PDD.*** Based on the design strategy, a CMSES (Context-based Multi-Sensory Experience System) is established to guide the early stage of PDD, namely during conceptualization, which is a highly crucial stage for creating

successful products and one that also has significant impact on product development lead time and cost.

5. *A guide to invite user contribution to usage contexts co-building.* The SCS (Scenario Co-build Strategy) is applied to address the issues of individual user differences while tackling the multiple contextual factors. It assists designers and users to work together and to co-build more customized usage scenarios so as to experience and evaluate a product under more realistic situations during user participation.
6. *A flexible and lightweight tool.* The UCF (User Context Form) is applied to deal with the diverse data regarding user background information and multiple contextual factors while applying SCS at the various stages -- from the preparation stage to execution and analysis stage.
7. *A practice of the proposed approaches.* Two case studies are conducted to demonstrate the feasibility and capability of the proposed approaches, and to explore and examine users' multi-sensory experience to greater depth and in a comprehensive manner. The first case study aims to demonstrate the CMSES and SCS while the second case study targets at illustrating the SCS and UCF. In addition, to achieve a fully-functional SCS, the level of freedom should be progressively raised. The first case study starts from 'low-to-medium' level of freedom to examine the potential and capacity on how users can contribute to the decision making of usage scenarios and observes the users' ability in immersing into their ideal scenarios. The second

case study then applies ‘medium’ level of freedom which invites users to further decide on more details regarding the contextual settings and co-build more customized usage scenarios. The work aims at establishing the foundation for SCS and provides essential experience for future studies to construct a higher level of freedom of SCS. The case studies are conducted in Singapore.

1.3 Originality and Significance

The personal experience of customers has become the key factor leading to product success. Designers are encouraged to ‘design for experience’, ‘design for emotions’, ‘design for senses’, and ‘design from context’. Hence, the study combines these directions into an integrated strategy – ‘designing for multi-sensory experience from a contextual level’. To effectively implement the strategy, the important task is to understand the users’ multi-sensory experience. The more that user experience and its aspects can be understood and taken into consideration (e.g., considering diverse individual differences under various situations), the more probable it would be for consumer-oriented and pleasing successful designs to be created. However, designers frequently face difficulties when investigating user experiences due to the inherent characteristics of experience such as its subjective, complex, and dynamic nature.

Although conventional methods, such as the scenario technique, can help designer explore user experiences under different situations, these methods fall short of considering individual differences when tackling multiple contextual factors. A systematic approach to guide the PDD in applying an integrated strategy has yet to be established. The study therefore re-examines the current

scenario technique and seeks to improve it by establishing a series of approaches that enable end users or consumers to create more customized usage contexts together with designers, and for users to interact with the product within these customized usage contexts. In doing so, the usage contexts employed in user involvement studies would be closer to users' real lives. Consequently, the user experience and evaluations collected can be expected to be more valuable, robust and reliable. Designers can be better inspired and new innovative ideas can be discovered. In addition, the experiential knowledge gained is traceable and can be useful for marketing and product planning.

1.4 Organization of the thesis

The thesis is organized as follow.

- Chapter 1 introduces the research background, identifies the research gaps and describes the objectives and scope of the research.
- Chapter 2 reviews related literature in the areas of user experience and current techniques and accordingly strengthen the research opportunities.
- Chapter 3 introduces the proposed approaches, namely the UXC, the CMSES, the SCS, and the UCF. The iterative UXC depicts 5 stages that encompass the user experience process. The CMSES and its characteristics are introduced. Based on it, the SCS and the UCF and their applications are presented.
- Chapter 4 presents a three-stage case study of a biscuit container design using the proposed 'context-based multi-sensory experience

exploration and design' approach. It demonstrates the CMSES and a scheme of SCS in practice. Users' multi-sensory experiences and evaluations are acquired and iterative design concepts are proposed.

- Chapter 5 presents a case study of an automated teller machine (ATM) design which demonstrates another scheme of SCS and the application of UCF. The influence of usage contexts on user experience is also discussed.
- Chapter 6 summarizes the research and presents the limitations of the current study as well as future work of the research area.

Chapter 2 Literature Review

This chapter presents the literature background of this work. The main objective of the research is to address the inherent characteristics of user experience while facilitating user involvement study in the early phases of PDD and NPD.

This Chapter begins with an introduction to current endeavour of product design and development, including the general background, the must of involving users, the shift of the roles of users, and the rise of the experiential demands. Next, Section 2.2 introduces the user experience and the inherently complex, subjective and dynamic characteristics of user experience. Subsequently, Section 2.3 provides an overview of four main design strategies that facilitate user experience studies. Along with the definition and inherent characteristics of user experience, this sets out the basis for the proposed integrated design strategy.

Section 2.4 reviews the facilitation of user involvement approaches and discusses issues pertaining to the application of current techniques to deal with design strategies. In order to address these issues, the study re-examines the scenario technique, identifying the advantages and the limitations. Opportunities and suggestions to improve current techniques are also identified. This then sets the direction of the research. Finally, a brief summary is presented in Section 2.5.

2.1 The endeavour of product design and development

2.1.1 The general background

The philosophy of concurrent engineering (CE), and its successor collaborative product development (CPD), has been widely applied in product design and development (PDD) for decades. It addresses the issues caused by the sequential development process, which is usually lack of communication among different functions of a company and requires long development times (Haque, et al., 2000; Riedel & Pawar, 1991).

On top of CE and CPD, the evolution of the PDD paradigm goes on because consumer goods are becoming more and more complex and customers generally expect more varieties, lower costs, better performance, higher quality and more rapid advancement (Swink, 1998). By properly incorporating the latest development in the realm of CE and CPD into the PDD process, companies may gain a competitive edge and have better opportunities to produce higher quality and cost-effective consumer goods in shorter time (Addo-Tenkorang, 2011).

The key concept of CE and CPD is the early consideration and involvement of all relevant elements of the product life cycle (PLC) (Winner, et al., 1988). Accordingly, the cooperation among multidisciplinary teams becomes indispensable. It is, therefore, necessary for these multidisciplinary teams to simultaneously consider much more complex requirements from different stakeholders (Shishko & Chamberlain, 1995). In addition, consumers' and users'

requirements should also come into play as they have become the focus in developing a successful product.

2.1.2 The necessity of involving users

The endeavour of PDD has shifted its focus from addressing functional and technological concerns to user-centred and consumer-oriented concerns in recent years (Chen, et al., 2009; Nagamachi, 2002; Sanders, 1999). The fulfilment of customers' needs and wants has, as a result, become an issue that companies inevitably have to face. Furthermore, due to keen competition, companies are compelled to go beyond merely satisfying average customer requirements such as producing market-focused products to incorporate a larger degree of personalization by offering customer-focused products (Jiao & Chen, 2006; Tseng & Piller, 2003).

This has often led companies to conduct user involvement studies and participatory design methods to discover the genuine voice of customers (VOC); to empathize with users; to understand their experience; and to capture valuable customer requirements (Carbonell, et al., 2009; Forlizzi & Ford, 2000; Visser, et al., 2007). With the fulfilment of customers' needs and wants being recognised as a key priority, it is important to treat users or customers as stakeholders and learn from them.

Involving users in the PDD has many positive effects such as improving users' preferences and satisfaction (Kujala, 2003), and applicability, acceptance, adoption of end designs and the potential of reducing development risk (Wilkinson & Angeli, 2014). There are more advantages one can learn from users in many different ways. In some cases, users can create quite original and valuable ideas and that user involvement can increase the likelihood of new

product success (Hippel, 2001; Kristensson, et al., 2004). Similarly, many innovation opportunities are actually derived from the interactions with customers (Terwiesch & Ulrich, 2009).

Companies are keen to facilitate customer/user research and innovative user-centred designs, the front-end creative phases of PDD such as the opportunity identification stage or the concept generation phase in particular (Cooper, 1998; Kleef, et al., 2005; Kristensson, et al., 2002; Visser, et al., 2007). Early customer and user input together with knowledge integration and decision-making have a crucial influence on the cost, time-to-market and the outcome of launching a product, especially in the context of new product development (NPD) (Chen & Yan, 2008; Hende & Schoormans, 2012; Yan, et al., 2011). On top of this, since customer research is especially important for NPD, it can be conducted at each basic stage of NPD process (Kleef, et al., 2005; Urban & Hauser, 1993).

Direct interactions with users throughout the entire design process are strongly recommended (Cardoso & Clarkson, 2012; Carroll & Rosson, 2007; Siu, 2003). Companies should have direct experiences with users, i.e. interact with customers and experience the use environment of the product. Otherwise, innovative solutions to customer needs may not be able to be discovered (Ulrich & Eppinger, 2008). Hence, it is of utmost importance to involve users in the PDD.

Yet one should be aware that merely listening to users' responses on questionnaires is no longer enough for developing successful products. In recent decades, the aim of HCI is also to get to know and understand the user, and design for a full range of human experiences (Wright & McCarthy, 2008).

Designers are further encouraged to be more empathic with users and to understand their feelings, situations and experiences (Kouprie & Visser, 2009; Leonard & Rayport, 1997).

Subsequently, the roles of users during the user involvement in PDD also require attention.

2.1.3 The shift of the roles of users

In the landscape of human-centred design research (see Figure 2–1), the horizontal dimension indicates different roles that users may play during a user involvement study (Pallot, et al., 2010; Sanders, 2006; Sanders & Stappers, 2008). On the one hand, users participate as subjects that respond to certain questions or stimuli. On the other hand, users are invited as partners or co-creators. User-centred design, which involves human factors/ergonomics, usability testing, contextual inquiry, applied ethnography and lead – user innovation, is located more on the left side, i.e. ‘users as subjects’, or in the middle; while participatory design such as generative tools and Scandinavian design lies on the right side, i.e. ‘users as partners’ (Sanders, 2006; Sanders & Stappers, 2008). The former tends to design for people, while the latter is more about designing with people (Sanders, 2006). No matter for which side, the importance and significance of user input is undoubtedly positive.

Figure 2–1. The roles of users in human-centred design research;

(adopted from Sanders, 2006; Sanders & Stappers, 2008)

As a matter of fact, in PDD and NDP, the focus no longer merely lies on the product being designed. Instead, users have become a critical component in the process. This new design paradigm, known as ‘Postdesign’, postulates that all the users have something to offer to a design process and they can be both articulate and creative when given appropriate tools to express themselves (Sanders, 2002). Besides, some other features of Postdesign such as being contextual, participatory, co-design, and being an ongoing process as needs and experiences change over time are also worth highlighting (Sanders, 1999, 2002).

One premise to design for experience is to learn to access users’ experiences (Sanders, 2002). One can learn from users about not only their memories and current experiences, but also their ideal experience. Apart from knowing what users say and think, or what they do and use, designers can further step forward to discover what users know, feel and dream (Sanders & Dandavate, 1999). Understanding more about users’ past, current as well as potential experience can make user experience the source of inspiration and ideation for design as suggested by Sanders & Dandavate (1999). As a result, it can better facilitate designing for experience. Accordingly, it is important for design researchers

and design practitioners to adopt suitable user involvement approaches to learn from users, empathize with users or even co-create with users.

2.1.4 The rise of the experiential demands

After emphasizing the importance of involving users during PDD and NPD, this sub-section focuses on the aspects which the designers need to pay more attention to.

As a matter of fact that different features can bring about different aspects and types of pleasures to users, designers should take a broader perspective and consider quality of design instead of merely satisfying the functional or technological needs (Siu, 2005). Especially in the highly competitive era, companies are tackling much more complex design problems which no longer involve only functional or cognitive aspect (Chen, et al., 2015b).

Similarly, it is suggested that not only the physiological factor, but also the psychological, cultural, social and ideological factors should be considered during the PDD in order to provide users with more pleasurable experience; meet more needs and wants and increase the degree of '*user fitness*' (Norman, 2013; Orr, 2002; Siu, 2005). It is important to note that beyond product functions, what consumers care more about are product value, product identity and the experience provided by the product (Djajadiningrat, et al., 2000).

Research in consumers' attitudes revealed that compared with material purchases, experiential purchases tended to evoke more positive feelings, such as happiness and enjoyment, and were regarded as more meaningful and valuable for personal identity and social relationships (Boven & Gilovich, 2003). Gilovich (2010) further suggested that consumers' long-term

satisfaction tended to increase for experiential purchases and decrease for material ones.

Hence, to create more consumer-focused and longer-lasting pleasing products for an emerging experience economy which emphasizes the selling experience (Pine & Gilmore, 1998, 1999), companies should turn the focus of their endeavours to the experiential aspect and not merely concentrate on the material aspect (Boven & Gilovich, 2003; Djajadiningrat, et al., 2000; Gilovich, 2010; Hassenzahl & Tractinsky, 2006).

2.2 User experience

Exploring and seeking comprehensive and in-depth understanding about more aspects of user experience have become an imperative and significant task for companies to create successful product and experience. This sub-section introduces the definition as well as the inherent characteristics of user experience.

2.2.1 What is user experience?

The term ‘user experience (UX)’ is conventionally associated with the realm of human-computer interaction (HCI). Its scope, however, is no longer limited to the traditional ‘usability’ aspect (Hassenzahl & Tractinsky, 2006). During the past years, user experience has been actively looked into with investigations covering traditional usability, cognitive and task-oriented aspects as well as the more hedonistic, emotional, aesthetic and multi-sensory aspects (Hassenzahl & Tractinsky, 2006; Norman, 2004; Schifferstein & Desmet, 2007; Schifferstein & Spence, 2008).

Essentially, when a user starts to interact with a product and receives information through his/her senses, ‘an experience’ of the product begins; there is also an end of the experience when this interaction is stopped. Between the beginning and end, the process involving continuous alternation of doing and undergoing that together shape the experience takes place (Hekkert, 2006). Clause 2.15 of ISO 9241–210 (2010) broadly defines UX as a person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service.

Another definition provided by Hekkert (2006) describes user's product experience as an entire set of effects that is elicited by the interaction between a user and a product. This includes the degree to which all our senses are gratified, i.e. aesthetic experience, the meanings we attach to the product, i.e. experience of meaning, and the feelings and emotions that are elicited, i.e. emotional experience.

2.2.2 The inherently complex, subjective and dynamic characteristics of user experience

The definition outlined in Section 2.2.1 also reveals that user experience contains sensory, cognitive and affective aspects (Chen, et al., 2015b). More specifically, it covers all possible aspects of experiencing a product that include physical, psychological, sensual, cognitive, emotional and aesthetic aspects (Forlizzi & Battarbee, 2004).

Regarding the aesthetic or sensory aspects, multi-sensory experience design has also attracted more and more attention since user experience is closely related to how the senses are stimulated and gratified (Schifferstein & Cleiren,

2005; Schifferstein & Spence, 2008; Spence, 2011). In addition, it should not merely focus on visual aesthetics but should consider all of the senses (Bloch, 2011). Actually, user experience can be enriched to a certain extent if there are more sensory modalities involved and more sensory memories activated (Schifferstein & Spence, 2008; Lindstrom, 2005). Researchers have studied sensory experience from several facets such as roles of the senses (Schifferstein & Desmet, 2007), sensory importance (Chen, et al., 2011; Fenko, et al., 2010) and various kinds of interactions between senses (Holmes, et al., 2007).

Besides, researchers also found that both internal and external factors contribute to the construction of UX (Chamorro-Koc, et al., 2009; Chong & Chen, 2010; Forlizzi and Battarbee 2004; Hekkert & Schifferstein, 2008). The internal factors include users' prior experiences, attitudes, beliefs, skills and personality, while external factors are closely related to the environment and usage context. Thereby, user experience owns the characteristic to be diverse and complex (Buchenau & Suri, 2000). This is identified as the first characteristic of user experience.

Experience is inherently personal and subjective. Attributes such as user's emotions, beliefs, preferences, habits, personality, personal goals, expectations, attitudes, skills and prior experiences all contribute to an experience (ISO, 2010; McCarthy & Wright, 2004; Pucillo & Cascini, 2014). Generally, every individual has quite different lifestyle, background knowledge and varying experiences. As it exists only in the mind of an individual, no two people can possess the same experience (Pine & Gilmore, 1998).

As suggested by Hekkert and Schifferstein (2008), experience refers to the subjective experience based on the individual's awareness of the psychological

effects elicited by the interaction with a product. In addition, sensory marketing is also more about the individual than the masses (Hultén, 2011; Hultén, et al., 2009). Hence, in order to create more value, it is important to engage and attend to customers in a more personal manner through differentiation and expressing a brand (Rodrigues, et al., 2011). Nowadays, as products are made and built with more functions and coupled with high rate of change in technologies, people's lifestyles as well as their expectations has become very personalized (Fukuda, 2015). Due to this change, engineers, who used to aim to achieve the best in objective evaluation, must now consider people's value in a more subjective way and also aim to satisfy each customer's expectations. The era then shifts from objective engineering to subjective engineering (Fukuda, 2015).

Without considering the subjective nature, a company may treat users in a too general manner and ignore crucial individual differences. Consequently, it may lose some valuable customer segments in a highly competitive business environment. Besides, to create products that can be used by most people under different situations, users should be treated as individuals with individual aptitudes, experiences and other human characteristics. As a result, all potential users' abilities as well as limitations should be taken into consideration during the PDD (Wilkinson & Angeli, 2014).

Basically, experience is dynamic due to the ever-changing internal state of a user's mind and the diverse external factors in the contexts (Law, et al., 2009; Vermeeren et al., 2010). It is also dependent upon an individual's dynamic relationship with other people, places and objects (Buchenau & Suri, 2000). For example, companionship is a powerful factor to have an impact on user experience (Chen, et al., 2012). Furthermore, during different usage periods,

users care about different aspects of product usage and experience. The attention may shift from hedonic aspects to meaningfulness as time passes (Karapanos, et al., 2009). In other words, the dominant evaluation criteria for evaluating goodness of a product would shift from time to time (Karapanos, et al., 2008). A user's multi-sensory experience would as well shift dynamically at different usage phases (Chen, et al., 2011; Fenko, et al., 2010). Thus, designers are actually dealing with moving goals and dynamic customers' needs (Blocker & Flint, 2007; Taylor, et al., 1999).

As suggested by Siu (2003, 2005), design studies should pay more attention to users' different experience under different physical environments, occasions, and cultural and social settings. Without carefully tackling the multiple contextual factors, users' experience as well as their evaluation may become ecologically invalid (Jakesch, et al., 2011). Thus, it is inevitable for designers to consider how multiple diverse contextual factors may influence user experience while conducting user involvement studies or user experience design.

In summary, user experience possesses inherent characteristics of being complex, subjective and dynamic (Buchenau & Suri, 2000; Zomerdijk & Voss, 2011). If these inherent characteristics are not taken into account, the knowledge and information obtained about users' experience and their needs and wants would be less accurate and certain important issues can be easily overlooked or omitted.

2.3 Design strategies facilitating user experience design

Although it is no easy task for a company to control or predict users' experiential needs and wants accurately (Zomerdijk & Voss, 2011), it is

possible and justifiable to provide customers with their desired experience or exclude some potential negative experience based on some prerequisites (Edvardsson & Olsson, 1996; Zomerdijk & Voss, 2011). The deeper and more comprehensive the designers can understand user experience, the higher the possibility for them to create long-lasting pleasing products. Thus, it is worthwhile to facilitate some design strategies and develop corresponding methods and tools to strengthen the user experience studies and design. Accordingly, some design strategies can be applied (see also Section 1.1).

2.3.1 Designing for experience

First of all, the general idea is to ‘design for experience’. The increase in product complexity and the urge to differentiate a product from those of competitors require companies to shift their attention to experience design (Stappers, et al., 2009). Djajadiningrat, et al. (2000) emphasized the importance of experience design and proposed a pamphlet emphasizing fun and beauty in product design. It used phrases such as “don’t think products, think experiences”, “don’t think beauty in appearance, think beauty in interaction”, and “don’t think ease of use, think enjoyment of the experience” aimed at encouraging designers to focus more on the experiential aspect than the product itself.

Designers are encouraged to treat users as experts of their own experiences. This includes designers paying more attention to the experiential aspect of user-product interaction, exploring potential user experiences, and implementing design for experience (Desmet & Hekkert, 2007; Hassenzahl & Tractinsky, 2006; Hekkert & Schifferstein, 2008; Stappers, et al., 2009). In other words, the VOC should capture the complete range of customer

requirements, from the explicit and the tacit to the tangible as well as the intangible. Hence, design effort should be extended to an experiential level instead of focusing only on the functional or technical requirements. By gaining knowledge on user experience at earlier stages, that is, before and during design conceptualization, a company benefits in that it is able to plan its marketing and design strategies at earlier stages. Furthermore, having greater confidence of its product and the experience that has been created to gratify users would put the company in a stronger position to plan ahead and chart critical next steps.

2.3.2 Designing for emotions

It is known that different design strategies can create different values. The two most common aspects of design identified are design as functional differentiation and design as emotional value creation (Noble & Kumar, 2008). The former can create transactional consumer outcomes while the latter can lead to more powerful values of loyalty, commitment, joy, and passion which in turn build better links for long-term customer relationships. Thus, more and more companies as well as researchers now are paying more attention to and even highlighting the emotional or affective aspect of user experience and the value of design for emotions.

For example, the importance of emotion has been raised in engineering perspective, such as emotional engineering, subjective engineering and Kansei engineering (Fukuda, 2011). Kansei Engineering has been developed as an ergonomic methodology to translate a consumer's feeling and image for a product into design elements (Nagamachi, 1995). The word '*Kansei*' in Japanese possesses many meanings, which include sensitivity, sense, sensibility, feeling, aesthetics, emotion, affection and intuition (Lee, et al., 2002). In a

broader sense, Kansei also covers total emotions as it provides an overall impression a person obtains (through all the five senses) from the outside world such as objects, environment and situations, and the inner status such as feelings and thoughts (Roy, et al., 2009; Nagamachi, 1995; Schütte & Eklund, 2003). For simplicity, Kansei can be defined as the customer's feeling and need relating to the product (Nagamachi & Imada, 1995). Since consumers' affective needs and thoughts can be collected, designers can create more successful products that can evoke more positive or rich emotions. Some researchers further investigate how different emotions, both negative and positive, contribute to user experience and evaluation (Desmet, 2012; Fokkinga & Desmet, 2013; Fredrickson & Cohn, 2008).

In fact, products that evoke more positive emotions are known to benefit many aspects of user experience. These include the ability to enhance usage comfort (Vink, 2005), to improve the general usability (Tractinsky, et al., 2000), and to decrease usage anxiety (Helander & Tham, 2003; Picard, 1997). Norman (2002, 2004) emphasized the importance of emotions and even proposed the slogan: "attractive things work better." Companies should not underestimate the value of designs that evoke positive emotions because they would be "*bought more often, used more often, and are more pleasurable to use* (Desmet, 2012)". These again proved the fact that 'emotion' can motivate our actions and affect our decision-making, especially in this age of increasing uncertainty (Fukuda, 2011). Hence, designing for emotions has become an essential and valuable design strategy.

2.3.3 Designing for multi-senses

Basically, designing for multi-senses is closely associated with the objective of generating positive emotional experiences. The design strategy is about gratifying all the senses together. In fact, the senses of human nature are fundamental and essential in order for people to explore and experience products. Human senses can collectively be treated as the first point of contact with a product, and can thus provide much useful and valuable information (van Kesteren, 2010).

In recent years, researchers in design-related domain started to study user experience from different aspects of sensory experience. These include the roles and contributions of the senses (Chen, et al., 2010; Schifferstein & Cleiren, 2005; Schifferstein & Desmet, 2007), sensory dominance/importance (Chen, et al., 2011; Fenko, et al., 2010; Fenko, et al., 2009; Schifferstein, 2006) and various kinds of interactions between senses (Holmes, et al., 2007; Ludden & Schifferstein, 2007; Ludden, et al., 2006). Not only is sensory experience strongly linked with aesthetic experience (Hekkert, 2006; Hekkert & Schifferstein, 2008), it is also closely associated with the affective and cognitive aspects of user experience.

First, aesthetic experience focuses on how users' senses are stimulated and gratified during user-product interactions (Hekkert, 2006; Hekkert & Schifferstein, 2008). However, not all the elements of full experience can bring about pleasure and gratification to the human senses (Hekkert, 2006). In this sense, the general goal for designers would be to enlarge the aesthetic elements of the full experience as much as possible in order to optimize the overall user experience.

Second, products that are more attractive to the senses have a higher possibility of evoking stronger emotions and are more likely to succeed (Vergara, et al., 2011). People's hedonic value is related to the stimuli perceived, such that different levels of arousal may be associated with different hedonic tones (Berlyne, 1974). Spence (2002) also highlighted the emotional role of the human senses, the sense of touch and olfaction in particular, in affecting people's emotions.

Third, successful products should offer a natural, logical and coherent sensory user experience. Failure to do so may lead to difficulty or even dangerous outcomes, a silent train cannot serve to warn passengers for example (Schifferstein & Desmet, 2008). From all these aspects, researchers have suggested that it is better to have more senses involved in the user experience. Furthermore, compared to uni-modal evaluations, multi-sensory evaluations are usually more precise and accurate (Gepshtein & Banks, 2003; Jakesch, et al., 2011).

On top of these, in practice, many companies notice the importance of providing a multi-sensory experience, not just in product design but also in marketing and branding. For example, the 'Samsung Experience concept store in New York' made use of its own signature fragrance that had been developed to enrich customer's olfactory sensory experience (Schifferstein & Desmet, 2008).

At the same time, a user's experience is affected by the richness of the perceived sensory information (Schifferstein & Cleiren, 2005). By involving more sensory modalities, user experience would be enriched to achieve higher quality (Schifferstein & Spence, 2008). Typically, a pleasant brand experience

is multi-sensory in nature (Spence, 2011). More than simply providing a distinctive benefit, a successful brand should deliver a full sensory and emotional experience (Lindstrom, 2005). It has been suggested that the greater the volume of sensory memories activated, the higher the likelihood that the brand's bonding with its consumers is strengthened. A successful example can be found in 'Singapore Airlines' which has always aimed to establish a true sensory brand experience encompassing more than what the passengers could see and hear as observed by Lindstrom (2005). Its patented aroma is considered a unique trademark that passengers can recognize upon stepping into the aircraft. The smell, which is strongly linked to comfortable flying memories, helps the airline brand stand out from its competitors.

In a multi-sensory experience, the value that is greatly emphasised is the contribution of the affective aspect. For example, Lindstrom (2005) suggested that emotional engagement can be considered a sensory branding strategy. Thus, in order to create an attractive product and deliver rich affective experiences such as evoking positive emotions, designers should consider applying a multi-sensory design or design for senses strategy.

2.3.4 Designing from a contextual level

Last but not the least, usage context plays an important role on user experience and should command greater attention in the early conceptualization stage. As advocated by Sanders (1999), the aim of experience design is to incorporate users' experiences of things, events and places in the design.

In fact, one essential characteristics of design is its dependence on the contexts, including both environmental factors such as products in the market place, and personal factors such as user's perceptions and attitudes (Taylor, et

al., 1999). Hence in the discussion of experience design, Djajadiningrat, et al. (2000) encouraged designers to consider creating a context for experience rather than just providing an experience. Similarly, Hummels, et al. (2001) emphasized this concept and redefined a product in terms of a context for experience.

The term, context, can be defined as ‘the environment of human-computer interaction’. The ISO (2010) also provides ‘context of use’ a general definition as users, tasks, equipment (hardware, software and materials), and the physical and social environments in which a product is used. In short, context is related to all the factors that influence users’ experience of a product (Visser, et al., 2005). Since it possesses a relational property holding objects or activities together, the scope of contextual features can be defined dynamically (Dourish, 2004).

As context is actively formed from users’ activities, differing from case to case and from individual to individual, a tool to integrate the user, the product and the world around him/her is worth developing to facilitate the user experience design (Pucillo & Cascini, 2014). Designers are encouraged to redefine the context and relevant contextual factors for each design problem (Visser, et al., 2005); continuously explore iterative prototypes (Buxton, 2007); and develop design tools to enhance the exploration and creation of the context and the experience (Hummels, et al., 2001).

The corresponding design strategy comprises a three-pronged approach: design-from-context for possible future users; postpone the focus on products; and develop ideas from a contextual level, through a user-product interaction

level, down to the product level (Stappers, et al., 2009). In short, this is known as ‘design from a contextual level’ strategy.

Nowadays, the importance of the concept of ‘contexts’ is raising and, as a result, UX studies are now paying more attention to it. For example, in the product ecosystem design, the boundaries are no longer merely focus on human-object interactions but extend to human-object-ambience interactions (Jiao et al. 2007). The product ecosystem includes three main categories of factors, namely ambient factors, user factors, and product factors. In other words, while starting from a contextual level, the focus shifts from conventional user-product interactions to broader user-product-context interactions. Figure 2-2 provides a summary of these concepts regarding the context for experience. All the factors that may affect user experience should be considered in the front-end of PDD and NPD.

Figure 2-2. The context for experience

In summary, the design strategies discussed in Section 2.3, namely designing for experience, designing for emotions, designing for multi-senses and designing from a contextual level, are not independent but complementary and can be applied in combination as integrated strategies. This study attempts to integrate these strategies to realise a design for multi-sensory experience from a contextual level methodology. The methodology encompasses a number of approaches to realise the task.

2.4 The facilitation of user involvement approaches – When current techniques meet the design strategies

In order to gain more insight into user experience and its inherent characteristics, which are complex, subjective, dynamic and context-dependent, issues regarding the usage contexts and individual differences should be taken into consideration from the beginning of the PDD during the user involvement studies. Although there are many techniques that can support customer/user research at the opportunity identification stage during a NPD process or the design conceptualization stage during a PDD process, there are still rooms for improvement to synthesize the aforementioned four design strategies, namely designing for experience, designing for emotions, designing for multi-senses and designing from a contextual level, to realise the proposed integrated methodology, i.e. *designing for multi-sensory experience from a contextual level*.

2.4.1 Some representative techniques

There are many methodologies and techniques that facilitate user-centred design or user involvement studies. Kleef, et al. (2005), for example, reviewed ten representative techniques to facilitate the understanding of consumer needs. Basically, these ten techniques comprise ① category appraisal, ② conjoint analysis, ③ empathic design, ④ focus group, ⑤ free elicitation, ⑥ information acceleration, ⑦ Kelly repertory grid, ⑧ laddering, ⑨ lead user technique and ⑩ Zaltman metaphor elicitation technique. An introduction to these techniques can be found in Kleef, et al., (2005).

First, although each of the aforementioned techniques can be used to solve a variety of problems in different phases of PDD, one common shortcoming is that many of them tend to focus more on the product aspects and not so much on the consumers' experience. For example, conjoint analysis in ② starts from selecting attributes relevant to product category, while the Kelly repertory grid in ⑦ and laddering in ⑧ emphasize much on the comparison and distinction between products. In this manner, consumers/users and designers may pay most attention on the details of product attributes from the very beginning and fail to consider a big picture of the user experience. Accordingly, as suggested Stappers, et al. (2009), it would be better to postpone the focus on products and think more about the experience at the beginning of PDD.

Second, although some of these techniques can be used to assist the exploration or investigation of user experience, many shortcomings do exist. For example, the so-called free elicitation in ⑤ uses stimuli props for participants to rapidly provide personal concepts that 'come to mind' first. Such

a technique is based on the assumption that the first mentioned is also the most important. However, what is mentioned first may simply be what is more obvious, common or can be more easily retrieve from memories. Furthermore, it only deals with the very surface and superficial things that it is not enough for companies to gain a deeper understanding of consumer experience or needs.

As for the sensory experience aspect, although category appraisal in ① considers sensory preference and perceptual attributes through ranking, rating or sorting, it mainly deals with the explicit aspect of knowledge because tacit knowledge cannot be so readily articulated and formalized.

Third, many techniques such as ①, ②, ④, ⑤, ⑦, ⑧, and ⑨ oftentimes fall short of considering usage contexts and the multiple contextual factors while investigating user experience or consumer needs. As for Kansei Engineering (numbered as ⑩; see also Section 2.3.2), it concerns users' feelings and psychological impressions (Jiao, et al., 2006; Nagamachi, 1995; Nagamachi & Imada, 1995). Users evaluate different products or stimuli based on the Kansei words prepared by design teams or researchers during Kansei evaluation (Jiao, et al., 2006; Roy, et al., 2009; Wang, 2011; Yan, et al., 2008). Thus, it can be used to capture users' affective demands and facilitate design for emotions. The results, however, are limited to the Kansei words pre-selected by the design teams and there will be no extra surprising response to inspire designers to think outside the box. In addition, it does not take the diverse usage contexts or contextual factors into considerations during the Kansei evaluation process.

Although the empathic design in ③, information acceleration in ⑥ and Zaltman metaphor elicitation technique in ⑩ do take usage contexts into

consideration when examining user experience, there are issues that need further investigations.

The empathic design in ③, which is more in line with the aforementioned design strategies, observes how users interact with products in their own environment and identifies consumer needs accordingly. Existing techniques such as user involvement field study can also be used to determine the actual UX more realistically under real situations.

In general, these techniques can be time-consuming and cumbersome (Vermeeren, et al., 2010). In some cases, they are neither suitable nor feasible to be carried out for the purpose of understanding the UX. On the one hand, they are not feasible if confidential or security issues exist. On the other hand, there are some challenges one may meet while tackling the usage contexts in a field study. These challenges are described as follows:

As users experience products in their own environment, usage context is included one at a time in the study. It would require more efforts from the design teams or researchers to record all the usage contexts in a consistent and systematic manner. Sometimes, a product is used in several diverse contexts. It would be more difficult to control or design the experiment. Furthermore, some possible contexts may be easily neglected or missed out. It is also less possible to include rich and inspiring usage contexts for NPD. For instance, possible future experience is normally excluded.

In the latter case, the information acceleration in ⑥ can be applied, for it brings users to an alternative future environment. A virtual buying environment, for example, which is fixed and set up by design teams or researchers, is assigned to the users. One possible issue is that such contexts created may not

fit into consumers' life closely. Although several environments that are favourable, neutral or unfavourable towards the products of interest, consumers still play a passive role in responding to these contexts.

As for the Zaltman metaphor elicitation technique in ⑩, it focuses on consumers' experience and the stories they want to tell such as their feelings, cognitive thoughts and mental models. It is able to deal with non-verbal expressions such as usage pictures and photographs, and has the potential to tackle tacit knowledge. Furthermore, the technique does not merely concentrate on the product itself but can cover the overall related issues. Multi-sensory experience can be explored if consumers have been informed or trained properly. Since consumers can photograph their daily lives, the usage contexts can be considered and discussed during personal interviews. It is important to note that this technique is often performed in a relatively freer and unstructured manner. User training or practices may be required to control the quality of the outcomes. Though it can be a very helpful technique to inspire design teams, it would require more efforts and time to manage multiple contextual factors as well as diverse complex experiential knowledge if companies expect to get more systematic and robust results. Another limitation is that product evaluation is not included in this technique.

2.4.2 Scenario technique

Scenario technique (numbered as ⑫) can be used to address the shortcomings of field test or empathic design. This section highlights the advantages and limitations of scenario technique, as well as the opportunities to enhance the technique.

The advantages of scenario technique

Sometimes, scenarios include not only usage context but also user activities, tasks and events, which are more like telling a story such as user interaction scenario (Rosson & Carroll, 2002), and scenario of use or sketch of use (Rosson & Carroll, 2009; Turner, et al., 2013). However, in this study, the term, scenario, represents the context of use or usage context, where a user experiences a product. Users can experience and evaluate a product based on a predetermined usage context or scenario. The advantages and limitations of scenario technique are presented in Table 1–1.

Scenario is a ‘lightweight’ technique that does not have too many rules and can be adapted according to one’s purpose and needs. For example, there are different types of scenario depending on the essential purpose. Scenario includes user stories or ‘use case’ scenarios, structures such as structured, semi-structured, or non-structured, characteristics such as formal, semi-formal, or informal, and abstraction levels such as conceptual or concrete. It can also be based on real or imagined experiences (Benyon & Macaulay, 2002; Imaz & Benyon, 1999). In addition, scenario can be carried out through various mediums, including descriptions such as textual narratives, sketches, storyboards, images, videos and live performances (Go & Carroll, 2004; Rosson & Carroll, 2002; Suri & Marsh, 2000).

Although different applications of scenario may focus on different viewpoints, hold different goals and have different levels of details, the use of scenario can still provide a common shared language for diverse stakeholders (Go & Carroll, 2004). Scenario is also capable of promoting empathy and stimulating thinking (Leite, et al., 2000; Rosson & Carroll, 2009). As it has the

power to describe the context in detail, and illustrate users' behaviour and activities, it has been widely used in strengthening user investigation such as user requirements extraction or requirement engineering, design conceptualization such as scenario-based design, brainstorming tool, planning such as strategic planning, and management such as decision making (Carroll, 1999, 2000; Go & Carroll, 2004; Potts, 1995).

Limitations of scenario technique

Although conventional scenario technique can be used to handle multiple contextual factors and facilitate user involvement, there are some biasness or pitfalls if designers fail to handle it with care. Scenarios are created by designers' ideations based on particular actors or activity contexts. The scenarios generated may be restricted and limited by the designers' perspectives or too narrow a view (Rosson & Carroll, 2009).

As the scenarios used in user involvement studies are created and decided solely by designers and then assigned straightaway to users, users play a relative passive role, i.e. merely responding to the assigned scenarios. In addition, the assigned scenarios may not actually have a good fit with users' real life situations. User experience and requirements collected in this manner would therefore have limited scope and, are, potentially, less accurate. In other word, conventional scenario technique is not capable of addressing the issue that involves users' individual differences in scenario usage, selection or construction. The limitations of conventional scenarios have also been discussed in Section 1.1 and further explained in Section 3.3.1.

As suggested by Rosson & Carroll (2002), scenarios have the power to direct one's attention. This is similar to the situation in the well-known story of

‘the blind men and the elephant’ leading to limited viewpoints and failure to see the whole ‘elephant’ (Go & Carroll, 2004). It is therefore imperative that scenarios are carefully designed to avoid such bias. Given that experience is a constructive activity based on the context set by the scenario (Sanders, 1999), the scenarios should link up closely with the real life situations of users. Only then would the experiences and evaluations acquired be useful and valuable.

In recent year, researchers begin to notice the value and importance of user’s associations with usage contexts when applying scenario-based investigation. For example, Jakesch, et al. (2011) incorporated a ‘free association phase’ in their study, where participants provided or state their own conditions such as *‘the material reminds me of granny’s old couch’*. Such an application, however, is very informal and unsystematic. Participants’ associations have wide diverse dimensions and possess different contextual references. Although the associations would involve some usage contexts, it would be a great challenge for designers to organize, digest, and make use of such unsystematic information. Some contextual factors may be emphasized by one participant but ignored by another. As there is no guideline or instruction for participants to refer to, some significant contextual factors can be easily neglected or even missed.

Take the above mentioned condition, *‘granny’s old couch’* as an example, it has mentioned the object, old couch, and a related person, granny, but has not indicated factors such as location, space, time and other companions. After all, ordinary people are not trained to pay attention to the diverse contexts around them and then describe the complex contexts, which involve multiple

contextual factors, in detail. Needless to say, everyone has his/her very own habits and ways to express ideas.

All these issues could cause biases, lead to unreliable deductions, and consume much more time, budget and efforts for designers/researchers to manage and analyse the information. These issues have not been properly addressed yet. In other words, a systematic methodology or approach that provides more customised usage contexts and takes into consideration individual differences when tackling multiple contextual factors for designers is still lacking.

Table 2–1. Summary for scenario technique

Advantages	Limitations	Opportunities & Suggestions
Scenario can ...	Scenario may ...	Scenario should ...
✓ direct one's attention and guides one's involvement	✗ be only controlled and set up by designers or researchers	★ be carefully designed to avoid bias
✓ deal with complex and dynamic factors	✗ cause bias	★ be rich enough to cover more aspects in order to reach the complete experience
✓ deal with multiple factors in a manageable manner	✗ lead to limited viewpoints and fail to see the whole	★ be co-created or co-built by more relevant stakeholders (e.g., users or consumers)
✓ describe the context settings in details	✗ not fit into user's real world due to individual difference	★ provide the freedom for users to co-build a more customized context setting with designers
✓ illustrate users' intention, behaviour and activities	✗ not link up closely with user's present status or over time status (for long-term participation)	★ be a continuous learning process
✓ be concrete yet still flexible		
✓ be easily adjusted and revised according to the applications		
✓ have different types, structures, characteristics and abstraction levels		
✓ be based on real or imagined experience		
✓ be carried out through different kinds of mediums		
✓ provide a common language for design		
✓ strengthen communication and collaboration among stakeholders		
✓ assist stimulating thinking		
✓ be widely used in different domains		
✓ provide specific context for more ecologically valid user evaluation		

2.4.3 Opportunities to improve current techniques

Table 2–2. A comparison of the twelve current techniques

#	Current Techniques	Emphasize on UX	Consider usage contexts	Consider individual differences in usage contexts	Tackle usage contexts in a systematic manner	Notes
①	Category appraisal	✓	✗	✗	✗	
②	Conjoint analysis	✗	✗	✗	✗	
③	Empathic design	✓	✓	✓	△	Not applicable while confidentiality / security issues exist ; Some possible contexts may be missed out
④	Focus group	△	✗	✗	✗	
⑤	Free elicitation	✓	✗	✗	✗	
⑥	Information acceleration	✓	✓	✗	✓	
⑦	Kelly repertory grid	✗	✗	✗	✗	
⑧	Laddering	✗	✗	✗	✗	
⑨	Lead user technique	△	✗	✗	✗	
⑩	Zaltman metaphor elicitation technique	✓	✓	✓	✗	Information collected in a free and unstructured way
⑪	Kansei Engineering	✓	✗	✗	✗	
⑫	Scenario technique	✓	✓	✗	✓	
Notations: ✓ – yes ; ✗ – no ; △ – depends (may differ largely from case to case)						

A general comparison regarding how the bespoke 12 techniques can be used to assist the identification of design strategies is shown in Table 1–2. Basically,

each of these techniques has its own strengths and weaknesses, and is meant for different design strategies. Although some of them can be used to assist in user experience exploration and investigation, issues pertaining to individual differences in usage context have yet to be adequately addressed.

Accordingly, a study to address these issues, improve current techniques and develop a more systematic strategy to facilitate the design for multi-sensory experience from a contextual perspective is required. The scenario technique (Table 1–1) has the advantages of being concrete yet flexible, open-ended and can be easily revised (Carroll, 2000). It, thus, provides opportunities for designers to adjust and adapt so as to avoid biasness.

As mentioned in Section 2.4.1, in recent years, users no longer merely play the role of subjects responding to stimuli during user involvement study in PDD and NPD. Designers are required to empathize more with users and even discover their dream products (Sanders & Dandavate, 1999). Stappers, et al. (2009) emphasized that users should be treated as experts of their own experience during user participation. Thus, user participation provides an excellent chance to encourage and motivate users to play a more active role so as to co-create or co-design (Sanders, 2006). In so doing, users may feel that they co-own or co-create their experience and, as a result, their evaluation would become more valuable (Beggan, 1992; Rijn & Stappers, 2008).

In addition, the study on user experience should be a continuous learning process. Hence, inviting users for long-term participation could be an effective method to facilitate co-design (Sanders, 2006). However, designers should realize that current experience will affect a user's future experience and fresh users should also be invited to experience and evaluate concepts in order to

avoid small group fixation and the learning effects caused by past participations (Stappers, et al., 2009). Accordingly, user experience provides the opportunities for users to decide the contextual settings or co-build more customized and realistic scenarios with designers. It would help in facilitating user involvement studies eventually, and can also help designers think outside of the box and empathize with users.

Furthermore, users should be invited to carry out tasks under several situations or scenarios so that they can evaluate and compare the same product, and acquire different experiences, i.e., experiential analogies (Goode, et al., 2010). On the one hand, different scenarios may encourage users to experience and evaluate the product more completely from various points of view. On the other hand, designers can have a better and more comprehensive understanding about consumers' dynamic thoughts and, hence, have better chances of capturing their tacit and latent requirements. Thus, the scenarios used should be rich enough to cover more aspects in order to attain a complete experience. Hence, this study attempts to exploit and incorporate the idea of co-build or co-create to enhance the scenario technique.

2.5 Summary

This work is based on the understanding that customers' personal experience has become a key factor leading to product success. In a highly competitive business environment, it is essential for companies to focus on consumers' experiences and requirements in order to offer more consumer-focused products with a larger degree of individuality.

To realise this, designers are encouraged to carry out design for experience, design for emotions, design for senses and design from context. Accordingly, an integrated strategy to design for multi-sensory experience from a contextual level is proposed. It has been established that although current techniques can help to facilitate the understanding of consumer needs, issues such as individual differences in usage contexts have not been thoroughly addressed.

Accordingly, this work attempts to improve existing techniques, and establish novel approaches to helping designer explore, investigate and understand the inherently complex, subjective and dynamic user experiences. In so doing, an integrated design strategy for the early concept development stage of NPD can be realised.

Chapter 3 Methodology

Figure 3-1. An overview of the proposed approaches

Based on the nature and characteristics of user experience, a series of approaches proposed in this study is shown in Figure 3-1. The first part of the approaches involves the construction of a User Experience Cycle (UXC) that depicts the processes of the user experience. The second part is a prototype Context-based Multi-Sensory Experience System (CMSES) that incorporates a Scenario Co-build Strategy (SCS), which is the third part. The CMSES is designed to facilitate the effectiveness and efficiency of context-based multi-

sensory experience acquisition and design. The SCS aims to take into account the individual differences of users in their personal ideal usage contexts during a user involvement study. Besides, a User–Context Form (UCF) is proposed as a tool for managing the multiple contextual factors in the SCS.

For the purpose of demonstrating the CMSES and SCS, a three-stage case study of a biscuit container design was carried out in Chapter 4. Similarly, a second case study of an ATM (automated teller machine) design was conducted to illustrate the SCS and UCF in Chapter 5.

3.1 User Experience Cycle (UXC)

Figure 3-2. The User Experience Cycle (UXC)

On the basis of the user experience and design strategies described in Chapters 1 and 2, a User Experience Cycle (UXC), as shown in Figure 3-2, is constructed to depict the proposed user experience process in detail. Corresponding to the aforementioned characteristics of user experience, i.e. dynamic, subjective, and complex, the UXC starts from a contextual level, taking into account individual differences (ID) as well as the multi-sensory experience (MSX). The UXC comprises five stages, which are outlined as follows.

Stage 1 of UXC

As depicted in Figure 3-3, firstly, as experience is dynamic and context-dependant, study of experience should be started from the contextual level. This means it is necessary to examine the usage context (UC) in which a user encounters a product. UC contains multiple contextual factors that relate to the users, environment of usage, and relevant products. Secondly, subjective issues should be considered when tackling UC. Individual differences (ID) in the contextual domain may include personal attributes, such as life style, cultural background and family structure. Let the UC that takes into consideration individual differences be denoted by $UC_{(ID)}$.

Figure 3-3. The stage 1 of UXC

Stage 2 of UXC

The stage 2 of UXC is depicted in Figure 3-4. A user experiences a product by gathering responses from his/her senses which are stimulated in the usage context. In this stage, the user interprets only certain responses for providing meaningful information. For example, in a daily routine experience where Joey is chatting on the mobile phone with his friend while commuting on a train, he neither pays attention to the broadcasting on the train, nor to the passengers close to him (e.g., he does not notice their faces, clothes, handbags or their actions). Although he may ‘see’ and ‘hear’ his surroundings, the nature and strength of the stimuli is not meaningful to Joey and, hence, would not affect his experience of talking to his friend. However, the situation may vary significantly from person to person.

Figure 3-4. The stage 2 of UXC

Figure 3-5. The stage 3 of UXC

Stage 3 of UXC

Figure 3-5 illustrates the stage 3 of UXC. Through continued user-product interaction, the user will then be able to gain experience in using the product and to evaluate its performance. Individual differences (ID) of users involving personal attributes such as sensory preferences, personal characteristics, personal values, skills and expertise, background knowledge, and previous experience, can also influence the user's experience and evaluation. Let the user experience (UX) that takes individual differences into account be expressed as $UX_{(ID)}$.

Since $UX_{(ID)}$ comprises three aspects, namely the sensory (SE), cognitive (CO) and affective (AF) aspects, mathematically,

$$UX_{(ID)} = \cup (SE, CO, AF)_{(ID)} \quad (1)$$

In other words,

Definition 1: User experience needs to take into consideration individual differences and it is an amalgamation of the sensory, cognitive and affective knowledge that a user has about a product.

In this manner, Equation (1) provides a means to mathematically formalise the relationships among user experience that takes into account individual differences, sensory, cognitive, and affective aspects. In practice, designers can first evaluate user experience from the perspective of sensory knowledge, and then try to relate that to the other two aspects. This is regarded as a more natural approach to evaluate UX as it minimises the risks of dwelling on partial aspects of the experience, such as a disproportionate emphasis on visual aesthetics. This implies that examining multi-sensory experience (MSX) may facilitate a deeper and more comprehensive understanding of UX.

Stage 4 of UXC

The stage 4 of UXC is illustrated in Figure 3-6. At the end of an interaction, a user would have performed an overall evaluation or assessment on a product. By taking into consideration personal attributes, such as affordability, family status and personal values, this overall evaluation may help the user make an informed purchase decision. Eventually, this might form a ‘pattern of use’ that influences the next experience when the user interacts again with a similar product. User experience is therefore a continuous and repetitive process that enables a person to accumulate knowledge about a product through many

interactions. This repetitive process would eventually form the user experience circle (UXC).

Stage 4

Figure 3-6. The stage 4 of UXC

Stage 5

Figure 3-7. The stage 5 of UXC

Stage 5 of UXC

Figure 3-7 provides an overview of the stage 5 of UXC. As articulated in Definition 1, designers can gain valuable, multi-faceted and deep knowledge about user experience in the UXC. First, experiential knowledge includes sensory, cognitive and affective aspects. Second, user experience is explored from a contextual level and its evaluation is elicited within a specific usage context (UC). Third, issues related to diverse individual differences (ID) are taken into consideration throughout the entire process, thus ensure the resulting knowledge gain of UX and customer requirements are closer to the users' real situation. Consequently, context-based experiential customer requirements (CXCRs) can be obtained as follows.

$$(CXCRs) = \cup [UC_{(ID)}, UX_{(ID)}] \quad (2)$$

Using Equation (1), Equation (2) can be re-written as

$$(CXCRs) = \cup [UC, (SE, CO, AF)]_{(ID)} \quad (3)$$

In other words,

Definition 2: Context-based experiential customer requirements ought to consider individual differences in usage contexts as well as different aspects of the user experience, e.g., the sensory, cognitive and affective experiences.

In this manner, Equation (3) expresses the relationships between context-based experiential customer requirements and factors that take into consideration individual differences such as usage context and different aspects of user experience. These factors can then be used as input by designers to improve the design concepts in an iterative manner. Additionally, the deeper, multi-faceted knowledge gathered through this method will enable the design team to implement a multi-sensory experience design strategy. This strategy is

highly conducive to creating successful products that can gratify more senses and, consequently, evoke more emotions (Schifferstein & Spence, 2008; Spence & Gallace, 2011; Vergara, et al., 2011).

In addition,

Definition 3: For a design project with a specific focus, relevant knowledge can be further gathered by examining the relationships of various factors. Generally, the relationships are given by the intersection of two or more factors as follows.

$$UX_{(S)} = \cap [UC_{(ID)}, SE_{(ID)}, CO_{(ID)}, AF_{(ID)}, \dots] \quad (4)$$

For simplicity, Equation (4) can be re-written as

$$UX_{(S)} = \cap [UC, SE, CO, AF, \dots]_{(ID)}; \quad (5)$$

where S = the specific focus of a design project; the factors on the right hand side of Equations (4) and (5) may need to be adjusted to fulfil S .

For example, when designing a shower system for elderly users, the design team needs to obtain knowledge on the usage context, i.e. bathroom, and on the users' multi-sensory, cognitive and affective experiences in using their existing shower systems. Applying the 'design from context' strategy to deliver more consumer-oriented outcomes that effect tangible improvements to the showering experience, design researchers would seek to further investigate the effects of multiple contextual factors on the users' sensory experiences. More specifically, the eyesight of the elderly may be poor making it difficult to discern the various bottles of shampoo, conditioner, and shower gel; due to deteriorating physical conditions, the elderly may find it difficult to adjust the knobs controlling the temperature and flow of the water; and a wet and potentially slippery floor would prompt users to seek features that can enhance

their sense of security and balance. Accordingly, contextual factors such as water and the design of the bathroom that includes attributes such as the space, size, layout, support and colour may all influence their experience to a certain degree. In this respect, the special focus of a project of this nature is to investigate the relationships of multiple contextual factors and sensory experiences. By applying Equation (5), the relationships, as a result, can be simplified as follows.

$$UX_{(s)} = \cap [UC_{(ID)}, SE_{(ID)}] = \cap [UC, SE]_{(ID)} \quad (6)$$

As shown in the above example, Equation (5) provides a means to mathematically generalise the relationships between user experience with a specific focus and factors that take into account individual differences in such aspects as sensory, cognitive, and affective. This might help in facilitating the communication among different stakeholders.

3.2 Context-based Multi-Sensory Experience System (CMSES)

- Ⓐ: Scenario co-building (based on a user's real situation)
- Ⓑ: Customized scenario(s) (for the user to experience the product)
- Ⓒ: Feedback of individual differences regarding usage contexts
- Ⓓ: Context-based user-product interaction (user experience)
- Ⓔ: Feedback of (multi-sensory) user experience and evaluation
- Ⓕ: Design and Marketing strategies concerning user experience
- Ⓖ: Context-based multi-sensory experience design

Figure 3-8. The proposed Context-based Multi-Sensory Experience System (CMSES) (Chen, et al., 2015b).

With an understanding of the overall user experience based on the UXC, a prototype Context-based Multi-Sensory Experience System (CMSES) is established to guide the PDD process from user-involvement studies to design conceptualization in a user-centric, consumer-oriented and experience-focused

manner. To address the subjective, dynamic and complex nature of an experience, the proposed CMSES has the following characteristics.

1. User experience is acquired under a specific usage context, which can prevent ecologically invalid results.
2. Individual differences are taken into consideration when tackling multiple contextual factors, thereby increasing the reliability of the results and bringing them closer to a user's actual situation.
3. As humans first perceive stimuli from their senses, it handles the multiple aspects of user experience starting from the sensory aspect and then progressively bringing in more and more of other aspects.

Corresponding to the subjective and dynamic nature of an experience, a Scenario Co-build Strategy (SCS) is proposed and applied. As shown in Figure 3-8: ①: the SCS invites users into the decision-making process of scenario-building, which by convention was done by design teams and users play only a passive role. With the SCS, designers and users are brought together to co-build a customized scenario which links up more accurately with one's real life situation (Chen, et al., 2012); ②&③: The customized scenarios not only help strengthen user-experience acquisition at a later stages of user involvement studies, but also provide feedback on individual differences within the usage context. The latter is of significant value to the marketing department; ④: In this manner, users are able to experience a product normally as they would in real life situation. This includes being able to treat the product as one who actually owns the product. A feeling of ownership is intentionally engendered such that the user becomes 'emotionally attached' to the product and thus become more motivated to share his/her experience in a greater detail (Rijn &

Stappers, 2008). In doing so, the user-involvement process also has an increased likelihood of producing more interesting and creative outcomes; ⑤: Consequently, designers can on the whole acquire more reliable and valuable feedback of user experience and evaluation.

Corresponding to the third characteristic which is the complexity of an user experience, designers get in the position to examine user experience in a more detailed and comprehensive manner given that they can connect the multiple sensory aspects with the cognitive and affective aspects. The general goals are to get an in-depth understanding of user experience and identify opportunities for multi-sensory experience design; ⑥: Accordingly, a company becomes better placed to plan the design and marketing strategies pertaining to user experience; ⑦: As a result, designers can conduct multi-sensory experience design from a contextual level in a more manageable manner such that a more long-lasting positive user experience is ultimately created.

3.3 The Scenario Co-build Strategy (SCS)

3.3.1 The raison d'être of SCS

To apply the strategy ‘start from a contextual level’, designers need to deal with diverse usage contexts at the outset of a user involvement study. The conventional scenario technique is often used to handle multiple contextual factors and deliver the usage contexts for end users to experience and evaluate a product. However, this technique disregards individual differences in users’ ideal usage contexts.

Figure 3-9. Conventional user involvement study (Chen, et al., 2015a).

Conventional scenarios used in user involvement study are usually set up by design teams based on certain general assumptions about the average target users or specific imagined individuals (Suri & Marsh, 2000). As shown in Figure 3-9, such scenarios are usually fixed and assigned to users during the user involvement study. Given this situation, users tend to have a passive role in

terms of their responses to the contexts as opposed to them taking an active part in expressing their ideas. In most circumstances, designers hold different insights such as social environment of use with respect to the users (Chamorro-Koc, et al., 2009). Therefore, one can hardly be faulted for doubting the suitability of using such scenarios to address diverse individual differences (Chen, et al., 2012). This can be critical as scenarios can influence users and direct their behaviours (Go & Carroll, 2004; Rosson & Carroll, 2002). In addition, the knowledge regarding users' individual preference of context of use is also not forthcoming and unavailable. As a result, companies are less likely to succeed in the quest to offer the "right" customer-focused products with a large degree of personalization.

Hence, to facilitate the user involvement studies, individual differences should be considered when the context of use is being prepared for users to experience a product. Consistent with this, designers are encouraged to treat users as experts of their own experience (Stappers, et al., 2009). Users are invited to play a more active role as partners or co-creators in the development of a product (Sanders, 2006). Based on this understanding, this study suggests that the scenarios selected for user involvement studies should have close association with the users' real-life experiences in order to capture more meaningful and valuable UX. Since the scenario technique is widely used and can be easily adapted, it is anticipated that users and designers are able to co-create more realistic customized scenarios. In doing so, certain pitfalls in scenario building can be avoided, e.g., one being relying on stereotypes instead of real people (Suri & Marsh, 2000). Moreover, in this manner, users may experience a product similar to what they usually do in real life and this likely

triggers a sense of ownership towards the product. Users then unconsciously develop a form of emotional attachment and become more ready to share about their experience (Beggan, 1992; Rijn & Stappers, 2008). In this way, the experience elicited can be regarded as more reliable and of higher value and accuracy. Furthermore, involving users in scenario-building naturally enhances the process, making it more interesting and improving the incidence of new creative ideas generated. Ultimately, companies can benefit and learn more from the users and in time to come, enjoy more successful product innovations (Poetz & Schreier, 2012).

3.3.2 An overview of SCS

A Scenario Co-build Strategy (SCS) is proposed for improving user involvement studies. The main concept for the SCS is providing a platform on which users can conceive potentially more suitable and more useful contexts where they can experience a particular product. It also attempts to address the following questions:

- (1) Are there really individual differences in users' preferred context of use for a specific product?
- (2) Is it possible for users and designers to co-build a more customized scenario or context of use?
- (3) How well can users immerse in the co-built scenarios and then be able to experience and evaluate the product?
- (4) Will the diverse contextual factors affect different aspects of UX in relation to individual differences? and

- (5) How can designers investigate into this in order to gain an in-depth understanding of UX?

Figure 3-10 shows the basic concept of the proposed Scenario Co-build Strategy (SCS). Here, users are invited to take an active role by contributing to the decision-making on the usage scenarios (Chen, et al., 2015a, b). Such a collaboration should be in place at the beginning of the user involvement study so that users can experience the product within their own co-built usage scenarios, which are customized from their real lives.

Figure 3-10. The basic concept of the proposed Scenario Co-built Strategy (Chen, et al., 2015b).

Unlike the conventional process (Figure 3-9), with the SCS (Figure 3-11), designers initially construct the basic structure of the system along with planning for the user involvement study. In the user involvement study, designers provide an adequate selection of scenarios for users to choose from. Alternatively, designers provide sufficient detailed instructions that guide users to co-build customized scenarios. Subsequently, the users will proceed to decide the ideal usage contexts that match their situation. They will also experience the product based on the co-built scenarios. This leads to the achievement of a more reliable and valuable UX. In addition, designers gain

knowledge of the users' individual preferences on the context of use as well as the factors behind their choice. Most importantly, the designers get into the position to observe and understand how the contexts may affect different aspects of UX in relation to individual differences. Consequently, the designers can acquire an in-depth understanding of the complex, subjective and dynamic experience of the users. This would possibly lead to the discovery of tacit and latent customer requirements as well as new opportunities for product innovation.

Figure 3-11. An overall framework of the Scenario Co-build Strategy (SCS)

(Note: see also the 5 stages in Figure 3-13) (Chen, et al., 2015a).

3.3.3 The characteristics of co-built scenarios

To apply the SCS, it is necessary first of all to understand certain basic characteristics of co-built scenarios. First, a flexible scenario technique allows co-built structures of varying extents, namely 'no co-built' (or 'fixed'), 'mixed' and 'fully co-built' scenarios. 'No co-built' scenarios are traditional scenarios set up by designers in which users do not contribute to the context settings.

Conversely, ‘fully co-built’ scenarios enable users to play an active role in deciding the types of scenarios the study will utilize. As for the ‘mixed’ scenarios, both ‘fixed’ and ‘co-built’ scenarios are employed. This implies that some scenarios used are assigned to the users while some are contributed by the users.

Figure 3-12. The levels of freedom for co-building scenarios

(Chen, et al., 2015a).

Second, where it concerns the co-building component, the design team has the flexibility to select the levels of freedom applicable to the co-built scenarios (Figure 3-12) depending on the design project and the target users' situation. Take a project for example which the target audience is elderly people, designers can offer several usage scenarios from which target users can choose, rather than expecting users to recall details of the usage contexts they have encountered. In some cases, designers can extend even more freedom, inviting users to decide the contextual factors and devising guidelines to manage the possible outcomes. To make such decision, some issues such as the number of

scenarios or range of contextual factors to be considered, the number of contextual factors, the ability of the users to change the context settings, the level of detail expected, and the extent of diversity allowed can be clarified. By manipulating the levels of freedom, the scenarios created can have a good fit with a user's personal lifestyle and exhibit distinct characteristics. At the same time, there are trade-offs that designers need to consider. For example, when several scenarios are available to choose from, the level of freedom is considered to be low-to-medium. This is similar to selecting one piece of apparel out of many in a boutique. The range of options that users can choose from is limited; the selection process is relatively straight-forward thus little or no training is required; and it is relatively easy for the designers to control the outcomes. However, most of the scenarios for selection are not surprising in general. One way to mitigate this shortcoming is for designers to seek users' inputs on the context of use or potential applications such as usage instances prior to revealing the prepared scenarios. Alternatively, they can also solicit users' feedback after users have experienced the scenarios.

In a situation where the SCS operates at a higher level-of-freedom, users are able to decide the context settings of a scenario. More diverse outcomes can be derived as a result as the stakeholders (including end users) may be more inspired and creative with their ideas. This resembles a situation where one purchases fabric to sew a dress and in the process, conceives and develops a new dress style design that not been seen before. Although the results are expectedly more complex and time-consuming to process, yet they are of greater value, particularly as novel ideas can emerge in the early stage of conceptualization.

Ideally, a fully-functional SCS is required to support the creation of a more complex co-built scenario and derive more diverse outcomes. However, corresponding increases in cost, lead time and effort will be involved to realise this. The trade-off depends heavily on the product development project. In new product development, companies may aim at achieving a higher level of freedom in concert with a well-structured process such that the co-built scenarios can be more creative, closer to users' expectation yet manageable. To do so, the designers need to begin at a lower level, and progressively raise the freedom level to a higher point.

3.3.4 The application of SCS

Although the application of the SCS depends heavily on the project on hand and invariably needs to be tweaked from case to case, some general guidelines are developed to assist designers, right from the planning stage through to the execution of the SCS. Five stages have been identified and are outlined as follows (Figure 3-13).

Stage 1 of SCS: Set up goals

Depending on the focus of product development at Stage 1, the designers may decide to accord priority to selected issues they consider as key. To ensure that the final SCS constructed is in line with the focus, it is imperative that these key issues are identified at the very beginning. Following this, the designers will be in position to establish clear goals and to stipulate the principles required to address the key issues.

Stage 2 of SCS: Deal with relevant issues

Many issues may affect how the scenarios are co-built. These issues have to be addressed before the SCS structure is defined. The two most basic and

crucial types of issues often relate to the product and the user. Designers can organize the issues into a ‘product profile’ and a ‘user group profile’ respectively. Apart from these, attention should be given to other practical issues such as project schedule, budget and tooling.

Stage 3 of SCS: Propose a scheme of SCS

Once the relevant issues have been attended to, at Stage 3, the designers can decide on the structure of the co-built scenario, such as whether it be ‘mixed’ or ‘fully co-built’. As previously mentioned, it is necessary to define the ‘level of freedom’ for the co-build scenarios. Two basic considerations are: (1) users can choose from multiple scenarios but are not permitted to change the context settings of their chosen scenario; and (2) users can choose from multiple scenarios and they can also opt to change the context settings of their chosen scenario. For the latter, there can be many ways to decide on the context settings. For example, users can choose to partially change the context settings based on sample scenarios, or build a customized scenario from scratch. Upon deciding on the co-built scenarios, the designers can proceed to construct the system and to propose a scheme for the SCS to guide the ‘co-built’ process. Designers can use visualization techniques to depict such scheme. The tasks, inputs and outputs from both designers and users ought to be identified.

Stage 4 of SCS: Design for experiment

In practice, Stages 3 and 4 are performed simultaneously as scenario co-building requires user involvement. In stage 4, designers explore possible methodologies to elicit and collect information. In addition, they decide where and when the study would take place and other details. Specific issues of a

technical nature are addressed, especially given that users have the freedom to decide the context settings. Ethical and confidential issues are also considered.

Stage 5 of SCS: Execution

In Stage 5, the designers prepare to execute the user involvement study. This includes preparing adequate scenarios and designing the ‘co-built’ interface. Ahead of the user involvement study, a pilot study is carried out to corroborate the functions of SCS. Upon completion of the pilot study, the designers review and improve the process to deliver a fully-functional SCS. A case study of a biscuit container design is presented in Chapter 4 to demonstrate these five stages and illustrate the capability of the proposed CMSES and SCS.

Figure 3-13. Five development stages for the application of the SCS

(Chen, et al., 2015a).

3.4 User–Context Form (UCF)

Figure 3-14. Application of the SCS in a user involvement study

As shown in Figure 3-14, in applying the SCS, designers are able to invite users to contribute to the decision-making of usage contexts and co-build more customized scenarios. A general User–Context Form (UCF) is proposed to manage the abundant information derived from usage contexts that take consideration individual differences in a user involvement study, from the stages of preparation and execution, i.e. user participation, to results analysis. The knowledge acquired can be used to assist in the subsequent iteration of designs.

A sample UCF sheet is shown in Table 3-1. It comprises such information as project name, utilization stage, i.e. when to use the data, and relevant stakeholders, i.e. who utilise the data. Information is collected from two domains, namely the user and his/her ideal usage contexts. The collected information can be presented flexibly in the preferred format of the relevant

stakeholders. At the same time, it can also be presented in a unified and organized manner.

Table 3-1. A sample of User–Context Form (UCF)

Project Name: (_____)									
Part (Number#). Used for (_____) When to use the data? (_____)									
Stakeholders: (_____) Who will use the data? (_____)									
#	Users' Background Info.				Multiple Contextual Factors				Notes
	User (U)				Usage Context (UC)				
	Factor 1	Factor 2	...	Factor n	Contextual Factor 1	Contextual Factor 2	...	Contextual Factor n	
...									...
...									...
	Relevant information and data (can be different format – literal data, coded data, image, etc.)								

For example, on the one hand, when designers start to plan and organize the target users' background information and the multiple contextual factors, they can choose an intuitive and straightforward way to simply fill in the factors identified as shown in Table 3-2. Designers or design researchers may further identify the parameters of these factors. Take the factor 'gender' for example, it includes two parameters, namely male and female.

Table 3-2. A sample of UCF (Designers as stakeholders)

Project Name: (_____)									
Part A. Used for <u>preparation stage</u> : identify user group and plan for user participation									
Stakeholders: Designers									
#	Users' Background Info.				Multiple Contextual Factors				Notes
	Target User Group				Preset Usage Context Settings				
	Gender	Age	Career	Income	Time	Event	Location	Companion	External Factors
	Male / Female								
...									
...									

On the other hand, programmers can provide definitions and formulate the information in a more systematic manner as follows.

Definition 4: Users' background information includes the users' gender (G), age (A), career (CA) and income (I). Mathematically,

$$U_{(ID)} = \cup (G, A, CA, I)_{(ID)}; \quad (7)$$

Definition 5: Usage context includes multiple contextual factors, namely time (T), event (E), location (L), companion (CO), and other external factors (EF). Mathematically,

$$UC_{(ID)} = \cup (T, E, L, CO, EF)_{(ID)} \quad (8)$$

Subsequently, the parameters of these factors can be further coded. Take the previous example – the factor 'gender', its parameters 'male' and 'female' can be coded as 1 and 2 respectively. Mathematically,

$$G = \{\text{Male (1), Female (2)}\} \quad (9)$$

Accordingly, the UCF in Table 3-2 can be revised as shown in Table 3-3.

Table 3-3. A sample of UCF (Programmers as stakeholders)

Project Name: (_____)										
Part A. Used for preparation stage: identify user group and plan for user participation										
Stakeholders: Programmer, design researchers										
#	Users' Background Info.				Multiple Contextual Factors					Notes
	Target User Group (<i>U</i>)				Preset Usage Context Settings (<i>UC</i>)					
	Gender	Age	Career	Income	Time	Event	Location	Companion	External Factors	
	<i>G</i>	<i>A</i>	<i>CA</i>	<i>I</i>	<i>T</i>	<i>E</i>	<i>L</i>	<i>CO</i>	<i>EF</i>	
	Male (1) / Female (2)									
...										
...										
...										

In this manner, design researchers can better use the information and facilitate result analysis and communication among diverse stakeholders. A case study of an automated teller machine (ATM) design project in cooperation with Wincor Nixdorf, Singapore, is described in Chapter 5 to better demonstrate the proposed SCS and UCF.

Chapter 4 The Case Study of Biscuit Container Design

To demonstrate the CMSES and SCS, a three-stage case study was conducted. At the first stage, users' multi-sensory experience and evaluation on 'Mary Biscuit' (a biscuit container design of the brand 'Alessi') were obtained and discussed. At the second stage, five design concepts for the biscuit container were developed based on the experiential knowledge gained. A survey was then carried out to evaluate the concepts, after which a preferred design was chosen and improved upon at the third stage.

4.1 The first stage

The main purpose of the first stage of the case study was to acquire knowledge of users' multi-sensory user experience from a contextual point of view. Based on the CMSES and SCS, the study illustrated how designers can explore and discuss users' multi-sensory experience concerning multiple contextual factors and diverse individual differences.

4.1.1 Methodology

The product chosen in the case study was 'Mary Biscuit' of the design brand 'Alessi' (see Figure 4-1). 'Mary Biscuit' stands out from other competitors by its design features, in particular the lid of the container which is biscuit-shaped, vanilla scented and with a special texture.

Figure 4-1. ‘Mary Biscuit’ of the design brand ‘Alessi’ (Chen et al., 2015b)

The research objectives of the case study were listed as follows.

- (1) To demonstrate the application of the proposed SCS based on the CMSES.
- (2) To show the individual differences in ideas regarding usage contexts based on the same product and the necessity of providing a greater number of customized scenarios in the user involvement study.
- (3) To explore the feasibility of allowing users to co-build more customized scenarios.
- (4) To examine the ability of users to immerse in the co-built scenarios.
- (5) To examine how different usage contexts may affect a user’s multi-sensory experience.

Two phases in this first stage of experience were defined as ‘trial’ and ‘usage’, respectively:

- (1) Trial phase encompassed the time when the users purchased the product and interacted with it for the very first time.
- (2) Usage phase encompassed the time when the users got to know more about the product and had fresh experience with it.

In terms of usage occasions, both ‘daily use’ and ‘special event’ were considered. In line with the abovementioned research objectives, certain

relevant issues were tackled before the SCS was constructed. Subsequently, a ‘product profile’ (Figure 4-2) was created to examine the issues related to the product. Likewise, a ‘user group profile’ (Figure 4-3) to help the designer deal with user-related issues and seek appropriate participation was created.

Figure 4-2. Product profile (Chen et al., 2015a)

Figure 4-3. User group profile (Chen et al., 2015a)

The process of co-building scenarios commenced as soon as both profiles were completed. This process comprised two phases of experience, namely 'trial' and 'usage' phases. The trial phase provided the participants the opportunity to try-out some features (of the product) and to single out a product feature that caught their eyes or appealed to them. This exercise helped in forming the first impressions about the product. It is generally accepted that a positive first impression is likely to influence the users to make a purchase decision at some point in time.

At the beginning of the trial phase, no product information was revealed to the participants. Without sufficient knowledge of the product, it was impossible for the participants to co-build a scenario, hence, the fixed scenarios were applied in the trial phase. It was assumed that after having tried out the product, the participants would acquire some knowledge about it and gain adequate experience about how the product could be used, including where it could be used and who could use it with. This exercise provided participants the opportunity to be more involved and to be in the position to contribute to the contextual settings.

Co-built scenarios were then deployed during the usage phase. Here, the co-built scenario structure was 'mixed' such that participants were given a certain degree of freedom to decide on the scenarios to be deployed. The level of freedom to co-build scenarios was set at 'low-to-medium'. This meant the participants could choose from multiple scenarios but without making any change to the contextual settings (Figure 4-4).

Figure 4-4. The ‘low-to-medium’ level of freedom for co-building scenarios (Chen et al., 2015a)

Table 4-1. Contextual settings of scenarios used in the case study (Chen et al., 2015a)

Phase (Way to provide scenarios)	Code	Scenario	Obtention	Product Representation	Product Function	Package	Companion	Space	Occasion
Trial (Assigned)	T1	Virtual Shopping 1: Online Webpage	Purchase	Virtual	Known	—	—	—	—
	T2	Virtual Shopping 2: Receiving Order	Purchase	Physical	Known	With	—	Indoor	—
	(Note that T1 & T2 should be carried out in order)								
	T3	Receiving Gifts at Home	Granted	Physical	Unknown	With	—	Indoor	—
	T4	Physical Shopping at Store	Purchase	Physical	Unknown	Without	—	—	—
Usage (Self-Choosing)	U1	Breakfast, <u>Alone</u>	—	Physical	Known	—	Without	Indoor	Daily Use
	U2	Breakfast, <u>with Family</u>	—	Physical	Known	—	With	Indoor	Daily Use
	U3	Afternoon Tea, <u>Alone</u>	—	Physical	Known	—	Without	Indoor	Daily Use
	U4	Afternoon Tea, <u>with Family</u>	—	Physical	Known	—	With	Indoor	Daily Use
	U5	Festive Seasons, (e.g., Chinese New Year), <u>with Companion</u>	—	Physical	Known	—	With	Indoor	Special Event
	U6	Examinations, <u>Alone</u>	—	Physical	Known	—	Without	Indoor	Special Event
	U7	Movie Marathons, <u>with Companion</u>	—	Physical	Known	—	With	Indoor	Special Event
	U8	Picnic, <u>with Companion</u>	—	Physical	Known	—	With	Outdoor	Special Event
	U9	Attending a Party, <u>with Companion</u>	—	Physical	Known	—	With	Outdoor	Special Event

Table 4-2. User's intended purposes of scenarios

Phase	Code	Scenario	User's Intended Purposes
Trial (Assigned)	T1	Virtual Shopping 1: Online Webpage	To get to know the product, form a mental image and make a purchasing decision
	T2	Virtual Shopping 2: Receiving Order	To examine the product(, unconsciously compare the expected experience to the real one), have better understanding and get familiar with it
	T3	Receiving Gifts at Home	To reveal the mystery about the gift, get to know the product and get familiar with it
	T4	Physical Shopping at Store	To get to know the product, (form an expected experience/occasion about it) and make a purchasing decision
Usage (Self-Choosing)	U1	Breakfast Alone	To use and experience the product in daily life: to have breakfast alone while the product is involved, to see how it fit into one's life
	U2	Breakfast with Family	To use and experience the product in daily life: to have breakfast with family while the product is involved, to see how it fit into one's life with related people
	U3	Afternoon Tea Alone	To use and experience the product in daily life: to have afternoon tea alone while the product is involved, to see how it fit into one's life
	U4	Afternoon Tea with Family	To use and experience the product in daily life: to have afternoon tea with family while the product is involved, to see how it fit into one's life with related people
	U5	Festive Seasons	To use and experience the product under a special occasion: to get together with (family or friends) at home during a festival, Chinese New Year, to see how it fit into one's life with related people
	U6	Examinations	To use and experience the product under a special occasion: to study at home during examination period, to see how it fit into one's life
	U7	Movie Marathons	To use and experience the product under a special occasion: to have a movie marathons with (family or friends) at home, to see how it fit into one's life with related people
	U8	Picnic	To use and experience the product under a special occasion: to go out for a picnic with companion (family or friends), to see how it fit into one's life with related people
	U9	Attending a Party	To use and experience the product under a special occasion: to go out to attend a friend's party, to see how it fit into one's life with related people

A total of 4 basic scenarios were assigned at the trial phase. For the usage phase, a total of 9 scenarios were created that participants could choose from.

The contextual settings for these scenarios are listed in Table 4-1. As shown in the table, the parameters for contextual settings include obtention, product representation, product function, packaging, companion, space and occasion.

Since the contextual settings differed from scenario to scenario, the user's intended purposes to experience a product would also vary (see Table 4-2). For example, the user's purpose in the 'receiving gifts at home' scenario (T3) was to reveal the mystery about the gift, get to know the product and become familiar with it. In addition, in the 'picnic' scenario (U8), the purpose was to use and experience the product during a special occasion, i.e. to go on a picnic with family or friends and to discover how the product would fit one's life as one interacted with other people. Generally, such information is likely to help designers better examine and discuss the relationship between usage scenarios and user experiences.

Based on the information collated, a scheme of the SCS was proposed as shown in Figure 4-5. During the trial phase, random sets of fixed scenarios were assigned to the participants which enabled them to experience 'Mary Biscuit' for the first time. In doing so, basic user experience and evaluation could be captured. After that, to gather novel ideas and avoid bias at the usage phase, the participants were asked to share what they considered to be their own ideal usage occasions or instances, prior to showing them the usage scenarios. Subsequently, the 9 scenarios (Table 4-1) were shown and the participants were invited to select the one they considered most suitable and to experience 'Mary Biscuit' once more. In this way, designers were able to capture not only more reliable and valuable user experience but also individual user preference in a manageable manner.

Microsoft's PowerPoint slides were used to guide participants choosing their preferred scenarios. These scenarios were represented using descriptors in the form of textual narratives, images for the context and videos for online scenario viewing to help participants build a mental model. One example of scenario representation is shown in Figure 4-6.

Figure 4-5. The scheme of the SCS proposed in the case study (Chen et al., 2015a)

SCENARIO 1

(Please read out loud)

I just receive my first salary since graduation and decide to do some shopping. So, I make my way to ION Orchard after work. I see a design shop “Alessi”, and decide to look around...

And this is what I see:

I picked up one of them and....

**Now you can start to experience the product.
Remember to think aloud!**

(You may ask the shop assistant for help.)

Figure 4-6. The representation of physical shopping at store scenario (T4)

SCENARIO 1

(Please read out loud)

It's public holiday and I have a long weekend ahead. So I decide to do some online shopping. I come across a cookie box called Mary Biscuit.

Figure 4-7. The representation of T1 scenario and the online webpage

As in the case of ‘virtual shopping 1: online webpage’ (T1) scenario, an interactive webpage was designed and participants could view and zoom on images as well as operate videos on-line. Although certain sensory information (e.g., product scent or special surface texture) is difficult to document, digitalize and then represent; and people may have difficulty experiencing a product based on limited sensory information, it is believed that close interrelations and interactions among the senses help compensate to an extent for the absence of some stimuli. For example, the auditory information can be used to improve the visual or tactile perceptions (Durlach & Mavor, 1995; Klatzky, et al. 2000;

Kunkler-Peck & Turvey, 2000). ‘Written descriptions and visual depictions of products’ can also be used to help people acquire tactile information (Peck & Childers, 2003). Thus, besides textual narratives and images, a ‘smell video’ and a ‘touch video’ are provided to compensate for the lack of tactile and olfactory information. Figure 4-7 shows the representation of T1 scenario and the online webpage while Table 4-3 shows the representation types and sensory information in the T1 scenario. Figure 4-8 shows some snapshots from the online videos.

Table 4-3. Representation types and sensory information in the T1 scenario

Sensory Information Representation Type		Visual Information	Auditory Information	Tactile Information	Olfactory Information
Textual Descriptions		Biscuit shaped lid, materials, capacity and dimensions	—	Materials	Vanilla scented lid
Images (Visual Information)		Product appearance, five colour combinations	—	Overall materials/ texture view	—
Videos (Visual, Auditory Information)	3D View	Turning product around to view from all directions	—	—	—
	Open View	Opening and closing the lid (Basic usage demo)	Product sounds when opening/closing	—	—
	Smell	Taking up the lid and smelling	—	—	Smelling the lid
	Touch	Zoom-in view of texture and touching product surface	Product sounds when touching	More detailed texture view; touching the surface with a finger	—

Figure 4-8. Snapshots from the videos

The experiment was conducted in the Design & Human Factors Lab, School of Mechanical & Aerospace Engineering, Nanyang Technological University. Two notebook computers were used to present scenarios and questionnaires, and two video cameras were used to record the process (Figure 4-9).

Figure 4-9. The experimental setting

(The left computer was for filling in questionnaires while the right computer was for presenting scenarios using powerpoint slides. The entire process was recorded by 2 video cameras.)

The overall process for the user involvement study is shown in Figure 4-10. Both qualitative methods such as think-aloud protocol (TAP), observations and interviews, and quantitative method using questionnaires were employed to capture different types of information.

The questionnaire, which consulted participants for their evaluations toward the user experience at the end of each scenario included criteria covering main aspects, viz., overall evaluation, functional aspect, emotional aspect, and sensory experience of four senses (vision, touch, audition and olfaction). The sensory experience aspect is further classified into four parts, viz., design features, sensory importance, sensory influence and experience evaluation. Figure 4-11 shows a part of questionnaire consulting the overall evaluation, functional, and emotional evaluation (by making use of a 7-point Likert scale).

Figure 4-12 then shows the example questionnaire of the evaluation related to sensory experience (taking ‘visual experience’ for example).

Figure 4-10. The user involvement process in the case study (Chen et al., 2015a)

I think the product experience 'Mary Biscuit' brings me is:

Please rate the descriptors that is most suitable for the 'Mary Biscuit' according to your own opinions:
(3: the strongest agree with the adjectives; 1: slightly agree)

Part A - Overall Evaluation

		Extremely	Quite	Slightly	Neutral	Slightly	Quite	Extremely	
A-1	Pleasant	3	2	1	0	1	2	3	Unpleasant
A-2	Attractive	3	2	1	0	1	2	3	Unattractive
A-3	Modern	3	2	1	0	1	2	3	Traditional
A-4	Interesting	3	2	1	0	1	2	3	Boring
A-5	Cute	3	2	1	0	1	2	3	Ordinary

Part B - Functional aspect

		Extremely	Quite	Slightly	Neutral	Slightly	Quite	Extremely	
B-1	Practical	3	2	1	0	1	2	3	Impractical
B-2	Durable	3	2	1	0	1	2	3	Weak
B-3	Safe	3	2	1	0	1	2	3	Dangerous

Part C - Emotional aspect

		Extremely	Quite	Slightly	Neutral	Slightly	Quite	Extremely	
C-1	Happy	3	2	1	0	1	2	3	Unhappy
C-2	Inviting	3	2	1	0	1	2	3	Rejecting
C-3	Active	3	2	1	0	1	2	3	Relaxed

Figure 4-11. An example of partial questionnaire on overall, functional & emotional evaluation

Product Features

Do these **Product Features** bring you **Positive** or **Negative** Experience:

D-2 Visual features:

	Positive :)	Neutral	Negative :(
Colour (Lid)			
Colour (Container)			
Colour combination (Lid+Container)			
Shape (Lid)			
Shape (Container: Whole)			
Shape (Container: Convex Bottom)			
Shape (Container: Opening)			
Middle-line of the container			
Size (Lid)			
Size (Container)			
Size (Container: Opening)			

~ ~ ~ ~

Now, let's evaluate each senses' role during the product experience:

Part D - the **Visual** Experience (...about what I **SEE**...)

D-5 How **important** is the sense of **Vision** during the product experience?

Least important	1	2	3	4	5	Most important

D-2 I think **Vision** affects my _____ toward the product. (Can choose more than one)

Overall **Evaluation**
 Overall **Experience**
 Functional Experience (e.g., Operation and Usage)
 Emotional Experience (e.g., Evoking Emotions and Feelings)
 preference (e.g., Like or Dislike)
 Willingness in Purchasing the product

D-7 I think the **Visual Experience** of 'Mary Biscuit' is:

	Extremely	Quite	Slightly	Neutral	Slightly	Quite	Extremely	
Big	3	2	1	0	1	2	3	Small
Beautiful	3	2	1	0	1	2	3	Ugly
Simple	3	2	1	0	1	2	3	Complex
Organic	3	2	1	0	1	2	3	Geometric

Organic: (irregular/ natural/ free-form) Geometric: (Regular and precise)

Figure 4-12. An example of partial questionnaire on visual experience

Since user experience might vary under different contexts, the questions used in interviews and questionnaires were tweaked accordingly. Apart from the common questions, additional questions depending on the contextual settings were also asked. For example, for the scenarios where there were companions around, the discussion included who the companion was, the

possible activities between companions and the kind of issues they would talk about.

Upon completion, 5 participants were invited to take part in a pilot study to execute the experiment. This was to ensure the user involvement process was proper and steady to be carried out formally. Subsequently, 33 participants comprising 15 female and 18 male participants with a mean age of 23.36 years old (ranged between 20 and 26) were invited to experience and evaluate 'Mary Biscuit'. During the trial phase, 11 participants were randomly selected and given 'virtual shopping (T1 & T2)' scenarios, another 11 participants were assigned 'receiving gifts at home (T3)' scenario and the remaining 11 participants were asked to work on 'physical shopping at store (T4)' scenario (see Table 4-4). After their first experience and evaluation of 'Mary Biscuit', each participant was interviewed on his or her ideal usage occasions or instances. Subsequently, the participants were asked to choose their preferred usage scenario(s) and to experience and evaluate 'Mary Biscuit' a second time as planned. The time for each participant was controlled in an hour.

Taking the case of one participant to provide a clearer illustration, Participant 30 (coded as P30) was assigned virtual shopping scenarios in the trial phase. After introducing the experiment process and a short practice (for think-aloud protocol, TAP), he experienced the product 'Mary Biscuit' under the online webpage scenario (T1). The presentation slides first showed him a description of the scenario and the participant was asked to read it aloud. An interactive online webpage (see Figure 4-7) was subsequently presented for participant to experience the product virtually based on the textual descriptions, images and videos provided (see Table 4-3 and Figure 4-8).

During the experience, the participant explored the webpage and spoke out what came to his mind, including his intention to perform an action, his thoughts and feelings (i.e., TAP) while researchers observed the process and recorded with two video cameras. After the experience, the participant completed a questionnaire to evaluate the user experience followed by an interview with researchers. The process – from presenting a scenario and a product to a participant to that same participant experiencing the product (TAP and observation), evaluating and discussing the product (questionnaire and interview) – was regarded as one full set for a single assigned scenario. The experience under the first scenario (T1) was the ‘pre-experience’ during the purchasing phase. The ‘first contact experience’ then took place at the ‘receiving order’ scenario (T2). After these two assigned scenarios, using presentation slides, 9 usage scenarios were introduced to the participant and he chose the one (or ones) in which he would experience ‘Mary Biscuit’ in the usage phase. In this case, the participant (P30) selected ‘afternoon tea with family’ scenario (U4) as an indoor scenario and ‘picnic’ scenario (U8) as an outdoor scenario to experience the product again. Both scenarios involved companions (family and friends respectively). All in all, the participant (P30) experienced the product under four completely different scenarios (T1, T2, U4, and U8) and the same process ran 4 times (e.g., 4 questionnaires were collected and 4 interviews were conducted). As a result, ‘Mary Biscuit’ was experienced and evaluated under both fixed (assigned) scenarios and co-built (self-choosing) scenarios. Quantitative data and qualitative information were gathered during the user participation. These abundance of information and data can assist the designer in investigating users’ multi-sensory experience at different phases and

under different usage scenarios. By doing so, one can facilitate the acquisition and understanding of users' subjective, dynamic and complex experiences in a more considered and comprehensive way.

4.1.2 Results and Discussions

Corresponding to the Research Objective 1 of the case study, this Chapter illustrated how designers could conduct a user involvement study based on the CMSES and SCS, from planning to execution. The discussions outlined below are based on the qualitative information and quantitative data collated. The qualitative information was extracted from the authors' notes, gathered from the verbatim of TAP and obtained by observations and from interviews. To ensure the information contributed by each participant was traceable, an identification code showing the participant's identification number, the source and the scenario was given. For example, 'P1, Interview, T1' denotes the information provided by Participant 1 during the interview of T1 scenario. Corresponding to the Research Objectives 2 to 5 of the case study, two main issues, namely 'the individual differences versus usage contexts' and 'the usage contexts versus user's multi-sensory experience', were discussed as follows.

4.1.2.1 The individual differences versus usage contexts

Usage instances provided by participants were diverse

After the trial phase, it was established that all participants were able to provide one or more usage instances. This included 'T1' scenario in which the participants did not interact with the physical product. It was found that examples of usage instances supplied by the participants were quite diverse and possessed different characteristics. Some were linked to their current life styles

while some were related to their dream experiences or future aspirations. Although most participants came up with usage instances that were similar or identical to the scenarios provided, some offered usage instances that were markedly different from the 9 usage scenarios provided (U1 to U9 in Table 4-1), such as ‘in the office’, ‘in an entertainment room’ or ‘as a gift for friends’. Such additional usage instances helped to enrich the scenario database of the SCS.

Individual difference in choosing usage scenarios

As for the usage phase, the scenarios chosen by the participants varied among the individuals. The record of the participants’ choices is presented in Table 4-4.

Table 4-4. Scenarios and participants record (adapted from Chen et al., 2015b)

Phase	Scenario Code	Number of Participants	Participant Code
Trial (Assigned)	T1	11	4, 12, 20, 21, 22, 23, 26, 28, 29, 30, 31
	T2		
	T3		
	T4		
Usage (Self-Choosing)	U1	2	1, 7
	U2	1	15
	U3	1	11
	U4	6	8, 22, 24, 28, 30, 31
	U5	11	3, 4, 5, 6, 10, 14, 18, 21, 25, 26, 32
	U6	6	2, 9, 12, 19, 20, 29
	U7	3	13, 23, 27
	U8	9	10, 16, 17, 18, 24, 27, 28, 30, 33
	U9	1	12

Figure 4-13. Total chosen times of the 9 usage scenarios (Chen et al., 2015a)

Of the 33 participants, 7 decided to go with 2 scenarios while the others each chose 1 scenario to experience. In total, all 9 scenarios were used in this case study. Figure 4-13 shows the distribution of the usage of the 9 scenarios.

The information collated has the following characteristics:

- (1) The most popular scenario was 'U5', followed by 'U8', 'U4' and 'U6'.
- (2) Scenarios linked to special events (30 times) were preferred compared to those designed for daily events (10 times);
- (3) Scenarios associated with companionship (31 times) were more popular than those without (9 times); and
- (4) Scenarios with indoor activities (30 times) were more frequently chosen than those with outdoor activities (10 times).

The results revealed that the participants appeared to have their own ideas about the usage context for the same product. This confirmed the necessity to provide the participants with more customized scenarios where they could experience and evaluate a product in the user involvement study.

Participants' reasons for deciding a usage scenario

Some of the reasons for rejecting a scenario appeared to be fairly similar. These included 'big', 'heavy', 'bulky', 'hard to carry' and 'the lid not secured' for the scenarios that involved taking 'Mary Biscuit' outdoors (U8 and U9). In addition, those who chose the same scenario seemed to give similar reasons. For example, 'aesthetic' was the main reason for choosing the 'U5' scenario. To these participants, 'Mary Biscuit' was special for its visual appearance that made it aesthetically presentable. Such an impression was further enhanced by integrating it with other sensory design features such as a vanilla scent and biscuit-like lid, that would make it an ideal commodity for festive seasons.

4.1.2.2 The usage contexts versus user's multi-sensory experience

Scenarios and diverse contextual factors seem to influence user experience in many different ways. Much evidence has been discovered and each item will be discussed in the following sections, from several sensory experience aspects to other user experience aspects. To better represent the experiential knowledge acquired, the qualitative and quantitative results were discussed together.

Participants' attitudes toward sensory importance

To discuss the multi-sensory experience, sensory importance was first examined. Participants' attitudes toward the importance of each of the senses were solicited using questionnaires after the experience of each scenario. The overall results showed that vision is the most important sense, followed by touch, olfaction and audition. Although for some scenarios the average scores appeared to be higher, yet it was established that there was no significant difference.

The questionnaire further solicited how participants' attitudes towards different kinds of design features could affect their purchasing decisions, such as for those who experienced T1, T2 and T4 scenarios (in which the obtainment of the product was through purchase, not granted as a gift). In total, there were 22 participants. The results suggested that most participants cared about tactile experience (counted 19 times), followed by special features (which can be related to a sensory experience once it showed the uniqueness against others) (18 times), and the visual experience (17 times). Seven (7) participants thought

olfactory experience was also a concern while none gave any credit to auditory experience.

It is known that among the five senses, vision is usually the dominant sense that collects more information, exerts greater influence, and attracts more attention during user-product interaction (Schifferstein & Cleiren, 2005). Yet, the sensory dominance or importance may be affected by product types (Schifferstein, 2006), product characteristics (Schifferstein & Desmet, 2007) and the stages of usage (Chen, et al., 2011; Fenko, et al., 2010). Although the study included both trial and usage phases in which participants experienced 'Mary Biscuit' on at least two occasions, the experiences were still very fresh and belonged to early phases of product usage (e.g., the early stage of user experience (Chen, et al., 2011) or the buying stage (Fenko, et al., 2010)). Usually at such phases, vision or sight can have more influence and importance than other senses (Chen, et al., 2011; Fenko, et al., 2010). Furthermore, in most situations, vision gathered the most information on a product in the shortest time compared to other senses (Schifferstein & Cleiren, 2005; Schifferstein & Desmet, 2007). All these could be the reasons why sensory dominance did not shift significantly and vision was the dominant sense at both trial and usage phases in this study.

Visual experience

Vision, in this case, played an important role in both cognitive and affective aspects of user experience. First, participants tended to rely heavily on vision to form the first impression, explore the functions, examine and evaluate the product. This was particularly apparent for the scenarios in which the main function of the product was not evident (as in T4 scenario where participants

had to locate the product on the showcase along with other goods without even knowing that it was a cookie container). In this instance, participants had drawn inference of the product function from the overall form (as a container) and the biscuit shaped lid (as one for storing cookies) (see the left picture in Figure 4-14). The result was in line with design philosophy ‘form follows function’ by Alessi. Second, the product’s overall form can elicit many kinds of associations. These included pillow, cushion, wrist rest, dog bone, UFO, red blood cell, fish tank, tissue box, flowerpot, massager, lamp, chair and stool. Such associations can further influence participants’ behaviour. For example, some participants did in fact handle ‘Mary Biscuit’ as a pillow – to be laid upon under the head or as a cushion to be hugged in the arms (see the middle picture in Figure 4-14). Third, many interactions were actually stimulated by the vision of the biscuit shaped lid (along with other sensory design features: colour, texture, scent). For example, *“the colour and texture of the lid, quite realistic smell, and feels like real biscuit makes me want to eat biscuit (P26, Interview, T2)”* and *“[pranking friends] hey, here's a biscuit, do you want to have a bite? (P10, Interview, U5)”*. Fourth, many positive emotions (e.g., happiness, surprise, funny, interesting and satisfaction) were evoked by the pleasing form of the container as well as the biscuit shaped lid. At the same time, certain negative emotions (e.g., disappointment, worry and concern) were evoked by the sight of the middle-line of the container (i.e., the line at the joint between the lower and upper parts as shown in Figure. 4-1) (see the right picture in Figure 4-14). This middle-line of the translucent container had a bearing on the aesthetic aspect as well as the functional aspect such as product durability, for example *“it makes me worry the Mary will break easily (P26, Interview, T2)”*.

Figure 4-14. Participants' visual experience

Figure 4-15. Participants' tactile experience

Tactile experience

It was found that the form of the product can further affect participants' tactile experience. For instance, the middle-line of the container may feel disturbing when overall form was being touched and handled (see the left picture in Figure 4-15). Consequently, the participants' feelings were affected. For example, *“I don't like this joint [action: touch the middle-line]; I'd like it to be one smooth piece (P28, Interview, T2)”*. Taking the concave shape of the bottom as a positive example, many participants praised the shape as friendly for hands to hold. For example, *“if I want to hold it out in one hand to serve people, the shape makes it quite easy to handle (P6, Interview, U5)”* (see the

middle picture in Figure 4-15). Using the sense of touch , participants could explore the detailed form instead of merely viewing the product (see the right picture in Figure 4-15). When there were special shapes or irregular contours, e.g., *“you have to feel and touch the shape; you can’t really view the entire shape, such as the bottom, and you can’t see the special nature of the shape until you actually touch it (P15, TAP, T3)”*.

Besides the form, the surface texture also matters significantly because it can increase the positive evaluation as well as evoke more positive emotions. In fact, it is suggested that designers should take very good care of every possible tactile feeling that a product may bring to users. As the above results show, tactile experience can affect the purchasing decision for majority of participants. Participants would examine the product in a more detailed way through touch and as a result even minor matters can develop into plus or minus points. For instance, the edge of the opening of the container can be a feature, e.g., *“I like the edge! Because it's not like normal containers that have quite a few jagged lines; this is really smooth (P29, TAP, T2).”*

Figure 4-16. Participants’ olfactory experience

Olfactory experience

In terms of olfactory experience, participants showed large individual differences on various aspects. First, participants reported a diverse range of individual sensory preferences or habits toward the vanilla-scented lid (see the left and middle picture in Figure 4-16). Some participants held a positive reception of the scent and were likely to highlight this feature to their (imaginary) companion, e.g., *“I tell you: this box is really special. Come, smell it. Go on, smell... smell (P5, TAP, U5).”* On the other hand, other participants harboured a negative attitude while some even stated that they may choose not to buy it, e.g., *“I am not a vanilla person; if it’s too strong, I won’t buy it (P26, Interview, T1).”* Nevertheless, there were also a few participants who did not consider the scent to be an issue. In fact, the participants’ personal preferences were closely linked with affective emotions. For participants who liked the smell, they tended to smell the lid more than once and while expressing positive emotions, e.g., *“I like to go back and smell it over and over again (P23, TAP, T2)”* and *“I’m very happy because of the smell; I bought the right thing (P4, TAP, T2).”* Participants who did not like the smell similarly behaved with strong emotions. What more, the emotions evoked by the scented lid (whether positive or negative) were much stronger than those evoked by other stimuli. It is known that olfaction has a very strong connection with emotions and relates closely to ones’ personal experiences as well as memories (Spence, 2002). As highlighted by Spence (2002), the importance of olfaction is obvious and *“the products of tomorrow will embrace the olfactory revolution (p. 3).”* Indeed, ‘Mary Biscuit’ with such an olfactory feature was found to trigger vivid emotions in users which also differentiated it from other containers. The

sensory preference also extended to what the participants' considered would be their likely attitude during the 12 to 18 months' as the scent faded away. Generally, those who adored the scent could opt not to wash the lid in hope that the scent could stay longer, whereas those who disliked the scent claimed they would wish to wash the scent away and would be more positive towards 'Mary Biscuit' once the scent had faded away.

A second area is the diverse difference in terms of individual interpretation of possible interactions of the vanilla-scented lid with the food stored inside the container. For example, a few participants held the view that the cookies stored inside could become more tasty. However, other participants worried that the food inside may be negatively affected by the scent and that the artificial smell in the food container could even be harmful to the body. As a result, the scent affected participants' decision-making regarding what the container may be used to hold (see the right picture in Figure 4-16). Some participants claimed they would not use it to contain food; some would choose biscuits inside wrappers so the flavour (of biscuit) would not be affected; some may avoid strongly scented food so the scent (of the lid) would not be a factor, and some stated they would choose the biscuit that could match the flavour of scent.

Despite huge differences in individual participants' sensory habits and preferences, the special olfactory feature did help 'Mary Biscuit' stand out from its competitors. Not only did the scent evoke numerous emotions and enrich one's affective experience, it represented an icebreaker that opened a new topic and enabled many interactions among people. However, in designing this kind of special sensory features, designers should also be careful about possible sensory interactions. As Schifferstein & Desmet (2007) addressed, a product's

final success depends on how all senses are stimulated and gratified. Therefore, it is important to design a more natural, logical, and coherent sensory experience.

In this case study, the chosen colour scheme of ‘Mary Biscuit’ was ‘Ice’, in which the container was translucent and the lid was of the normal biscuit colour. It seemed logical and coherent when the biscuit colour matched the vanilla scent. Nevertheless, other colour schemes of ‘Mary Biscuit’ provided by Alessi also included white, orange, blue and green colours to go with only one flavour of smell – the vanilla scent. In the study, participants could distinguish the different colour schemes from viewing the online shopping webpage (in T1), or by the packaging as they were receiving it as a gift (in T3), or by requesting the clerk to show them (in T4). One participant initially said he preferred green colour. However, once he realised the scent would still be the same vanilla flavour, he immediately changed his mind. Further, he commented that the combination was “*definitely a wrong design concept* (P8, Interview, T4)” and proceeded to suggest an additional choice of scent be provided (besides colour), i.e. “*not only depending on colour preference, but also smell preference we can choose* (P8, Interview, T4).” Besides the sensory interactions, it also appeared worthwhile for designers to identify how the context may affect one’s sensory preference. For example, one participant while experiencing the ‘Examinations (U6)’ scenario noted that “*if I’m studying, I’d rather this [the lid] is coffee scented* (P29, TAP, U6).”

Considering possible individual sensory preferences, the afterward questionnaire solicited participants’ preferences toward the flavour of the scent. The results showed that 17 participants preferred no smell at all while 12

participants chose the same vanilla scent, 11 for fruits scent, 3 for other cookies scent, and no participant considered perfume style. Thus, while planning or designing a product and its multi-sensory experience, design teams should exercise careful consideration of including possible sensory interactions as well as the diverse individual sensory preference and habits.

Auditory experience

In discussing auditory experience, the product sound selected for consideration was of the sound produced while closing the lid. This sound was found to be closely related with the functional aspect – the tightness of lid. This could be an important issue for a food storage product where ‘air-tight seal’ quality is an essential consideration. It was a commonly-held view by participants that if the lid could close tightly while being pressed shut, a clear clicking sound as an audible feedback should be provided. Hence, when the container produced a light and soft sound instead, many participants expressed their concerns. This also evoked some negative emotions (e.g., worry, concern, disappointment and unsafe). As was the case with the other senses, individual differences emerged in personal sensory preference and interpretation of the product sound. In the case study, a few participants noted the positive aspects of the light and soft sound, e.g., “*it is well designed and well-constructed* (P28, Interview, T2)” and “*normally there must be a loud sound to close it tightly, but this can close tightly yet the sound is quiet* (P33, Interview, T4).” Apart from that, some participants found that since ‘Mary Biscuit’ was less noisy than other containers, it could fit well into some special usage occasions, e.g., “*snack in middle of night will feel less guilty* (P29, Interview, T2)” and “*Mary is suitable for the library since it got no sound* (P29, Interview, U6).”

Sensory design features and usage occasions

Based on the above findings, it is suggested that sensory design features might be able to affect a product's suitable usage occasions to a certain extent. In this regard, more than just designing from a contextual level (Stappers, et al., 2009), it is further suggested that designers should always return to the contextual level after design conceptualization to check that the different sensory design features do help the product fit well to the targeted usage contexts.

Individual sensory preference versus designs in the market

Interestingly, among all the multi-sensory experiences, it would seem that individual differences exist the most in the olfactory and auditory experiences. The cause for the differences may lie in several aspects, including personal sensory preference (e.g., like/dislike a sensory design feature), personal sensory habits (e.g., care how much about a sensory gratification or have special concerns regarding a sensory experience), individual interpretation of a stimulus or phenomenon (e.g., have different viewpoints of an event) and personal sensory sensitivity (e.g., initial feelings of perceptions or physical sensitivity toward a stimulus). Nevertheless, most products in the market today primarily emphasize the visual aesthetic (Fenko, et al., 2010). Some may go on next to strengthen the tactile gratification. However, few consider special olfactory or auditory experience unless the product is directly or strongly related to smell (e.g., perfume, deodorant) or sound (e.g., musical instruments, washing machine). In other words, in purchasing a product, a customer can expect to find plenty of choice in terms of forms, sizes, colours, materials and even textures, but little or no choice in terms of special olfactory or auditory

features (except where these are related to the product e.g., perfume). The example of the olfactory experience in this case study therefore illustrated that participants had diverse needs and wants regarding the olfactory experience. Yet, no opportunities were provided for them to select their preferred sensory features, e.g., the intensity or flavour of the scented lid. As a result, some customer segments could not be satisfied and the company further risked losing the segments that tended to have stronger personal sensory preference or sensory habits.

Hence, it might be a good opportunity for a company to design its product for all the senses (i.e., multi-sensory design), taking into consideration individual differences and through this to satisfy more customer segments as well as to differentiate its product from many competitors. For example, the concept of ‘mass customization’ can be applied to increase the range and diversity of sensory design features (and sensory experiences) while maintaining control over manufacturing cost. In this way, more customized and personalized product that can be created to better fit an individual customer.

The influence of contextual factor – e.g., companionship

One can also examine and discuss how a single contextual factor may affect user experience. The following discussion uses ‘companionship’ as an example to address the issue.

Based on observations, ‘Mary Biscuit’ seemed to suit the ‘U5’ scenario well, in particular the companionship factor. Its design features had attracted much attention and facilitated interaction with the participants. Apparently, the experience ‘Mary Biscuit’ provided would influence the participants in how they decided on its suitability for a particular usage context. Similar situations

could also be found in other scenarios (U2, U4, U7, U8 and U9) where the usage contexts were linked to companionship. Different types of social events were mentioned repeatedly by the participants. ‘Mary Biscuit’, unlike other common containers, was able to help break the ice; it provided a talking point and facilitated interactions.

On the contrary, in the scenarios not associated with companionship such as ‘Examination (U6)’, it was observed that the participants frequently did not pick ‘Mary Biscuit’ from the desk; neither did they show care or interest in its appearance. It was apparent that more emotions were invoked when the contextual settings were associated with companionship. In fact, some participants felt their experience would be different if there were people around. Thus, it can be deduced that contextual factors such as companionship may influence users’ attitudes, thoughts, behaviour and emotions.

Intended purposes of scenarios can affect user experience

Contextual settings are scenario-dependent. Likewise, the intent of a participant to experience a product under different scenarios may vary. This issue is mentioned in section 4.1.1 and organized in Table 4-2. For example, during the trial phase, the intent of a participant in experiencing ‘T1’ scenario was to get to know ‘Mary Biscuit’ in order to create a ‘mental model’ and to make a purchasing decision while the purpose of attempting ‘T2’ scenario was for the participant to examine ‘Mary Biscuit’ and compare it with the expected experience.

Apart from these, it was found that the availability of additional information would influence participants’ behaviours. For example, participants who had experienced ‘T1’ scenarios and had been provided with product specifications

were observed to examine the product later right at the start of 'T2' scenario. On the other hand, the participants who had earlier experienced 'T3' and 'T4' scenarios (where product specifications were not provided), would start by making several guesses on the possible usage of 'Mary Biscuit'. In 'T2' and 'T3' scenarios, 'Mary Biscuit' was packed in a box. This generated a feeling of mystery and consequently, all the participants seemed to be very happy and elated when the box was finally opened.

Different products may be suited for different occasions

It was found that some participants preferred to use different containers at different occasions. For example, some felt that 'Mary Biscuit' was suitable for special occasions (e.g., family and friends reunion; festive seasons; in a library; during midnight). However, it might not be appropriate for daily usage due to functional concerns. They prefer traditional containers which can keep more air-tight for daily use.

Quantitative evidences on the influence of scenarios

Apart from qualitative reasoning, the influence of scenarios can also be assessed quantitatively. In this work, questionnaires were used to solicit the assessments of the participants after experiencing each scenario. Seven criteria, namely overall evaluation, functional experience, emotional experience, and sensory experience of four senses were used, that is vision, touch, audition and olfaction. The sensory experience then further covered design features, sensory importance, sensory influence and experience evaluation.

A single factor ANOVA (analysis of variance) was conducted to ascertain the effect of scenarios by participants and the seven criteria. The significance of

scenarios for each participant was evaluated and assessed against the seven criteria using a three-point scale. On this scale, ‘1’, ‘2’ and ‘3’ denoted ‘insignificant’, ‘moderately significant’ and ‘significant’, respectively. Subsequently, the scores for each participant and each criterion were accumulated separately.

Table 4-5. The significance of scenarios by participants (Chen et al., 2015a)

Participant	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	
Score	25	21	25	23	21	26	21	21	35	26	23	
Participant	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	
Score	30	23	25	25	22	29	25	24	25	23	33	
Participant	P23	P24	P25	P26	P27	P28	P29	P30	P31	P32	P33	SUM
Score	33	29	25	27	21	28	25	26	29	26	24	844

It is apparent that scenarios have an effect on individuals as well as on the various aspects of criteria. The single factor ANOVA for scenarios and participants (Table 4-5) shows that the average and the range of the scores registered are 25.58 and 14 (spanning from 21 to 35), respectively. Thirteen (13) participants scored higher than the average. Among them, 7 were assigned ‘T1’ and ‘T2’ scenarios, 4 with ‘T3’ and 2 with ‘T4’ scenarios during the trial phase. It appeared that those who experienced ‘T1’ and ‘T2’ scenarios tended to give a higher score. This also implies that in virtual shopping, the gap between ‘expected experience’ and ‘actual experience’ can be large at times as users tend to have a higher expectation of the product. Hence, such a phenomenon needs to be taken into account when user involvement study is to be conducted virtually.

As for the single factor ANOVA for scenarios and criteria (Table 4-6), the average and range of the scores registered are, respectively, 40.19 and 24 (spanning from 33 to 57). The criteria of ‘overall evaluation’, ‘emotional

experience’, ‘visual experience – design features’, ‘tactile experience – design features’, and ‘olfactory experience – design features and experience evaluation’ all received above-average scores. Hence, the scenarios presented appeared to have a greater influence on these criteria.

Table 4-6. The significance of scenarios by criteria (Chen et al., 2015a)

Aspect of Criteria	A/a	A/b	A/d	B/a,d	C/a,d	D/a	D/b	D/c	D/d	E/a	E/b
Score	57	33	46	40	49	35	51	35	33	38	57
Aspect of Criteria	E/c	E/d	F/a	F/b	F/c	F/d	G/a	G/b	G/c	G/d	SUM
Score	35	34	39	35	35	35	46	42	35	34	844

Notation:

(A) – overall evaluation; (B) – functional aspect; (C) – emotional aspect; (D) – visual experience; (E) – tactile experience; (F) – auditory experience; (G) – olfactory experience; [()/a] – 7-point Likert scale; [()/b] – design features/variables; [()/c] – sensory influence; [()/d] – the entire of the aspect

The participants’ self-reports on the influence of scenarios on their evaluation

A post-survey was carried out at the end of experiment (see an example in Figure 4-17). The results, as summarized in Figure 4-18, show that scenarios can have influence on ‘overall experience’, ‘overall evaluation’, ‘functional experience’, ‘emotional experience’ and ‘willingness in purchasing product’ for most participants, and on ‘preference’ for a few participants.

I think that different **Scenarios** would affect my _____ toward the product. (Can choose more than one)

Overall Evaluation

Overall Experience

Functional Experience (e.g., Operation and Usage)

Emotional Experience (e.g., Evoking Emotions and Feelings)

preference (e.g., Like or Dislike)

Willingness in Purchasing the product

Figure 4-17. An example of the self-report question answered by P12

Figure 4-18. Participants' self-reports on the influence of scenarios on their evaluation (adapted from Chen et al., 2015a)

From the above 12 issues discussed, it is apparent that scenarios possess the power to influence user experience in many ways, including sensory, cognitive and affective aspects. Thus, apart from the observation that scenarios can direct users' attention (Rosson & Carroll, 2002) and guide user involvement (Go & Carroll, 2004), this work further suggests that scenarios can influence various aspects of a user's multi-sensory experience.

The participants' ability in imagining scenarios

Corresponding to the objective 4, this section discusses the participants' ability to imagine and immerse in the co-built scenarios. This issue is important as the ease of imagining a new product or experience may affect users' attitudes and evaluation behaviour (Zhao, et al., 2012). It has been postulated that the ability of the participants to imagine a scenario might have a bearing on the quality of user experience captured. This study investigated how well a participant can imagine a scenario in two ways, namely the objective and subjective ways.

First, techniques based on cognitive science such as TAP can be used to perform an objective assessment of the extent of immersion. Using TAP, the participants can spontaneously share their experience and thoughts. In this work, some participants were able to vividly describe the scene in their own words, or to rationalise their behaviour vis-à-vis the contextual settings in the scenario. For example, participant 17 claimed that *“I’ll pack a food for a pair to eat (P17, TAP, U8)”* while choosing food to put inside ‘Mary Biscuit’ because she imagined having a date or a picnic, with her boyfriend. Some participants even presumed to stand in the shoes of others in the scenario experience. For example, in the interview when participant 5 was asked why he did not want to store candies in ‘Mary Biscuit’, he explained that *“since the lid is in the shape of a cookie, others may think that inside are also cookies. But if they found inside are actually candies, it doesn’t feel right (P5, Interview,U5).”*

The second way to investigate how participants imagined a scenario can be by asking the participants directly for a more subjective assessment. In a post-survey, the participants completed in a questionnaire that consulted their ability to imagine the scenarios (see an example in Figure 4-19). As shown in Figure 4-20, the results suggested that 82% of the participants responded that they found it possible to visualise scenarios, while 18% of them might have problem doing so. Together with previous evidence obtained that all the participants are able to give usage instances, to choose ideal usage scenarios for ‘Mary Biscuit’, and to experience it accordingly, this work has shown that the chances are good for participants to co-build more customized scenarios that facilitate user involvement study.

To what extent can you imagine the scenario?							
	Extremely	Quite	Slightly	Neutral	Slightly	Quite	Extremely
Can't imagine at all	3	2	1	0	1	2	3
							Can imagine clearly

Figure 4-19. An example of the question consulting participants' ability in imagining scenarios answered by P12

Figure 4-20. Participants' ability to visualise the scenarios (Chen et al., 2015a)

4.2 The second stage

The main purpose of the second stage of the case study was to carry out concept generation for the biscuit container design.

4.2.1 The biscuit container design

Based on the experiential knowledge acquired from the first stage, 15 design concepts were created for the young segment (see some sketches of the designs in Figure 4-21). These concepts were further categorised into 5 groups. From each group, a final design concept was chosen and revised and total of 5 biscuit container design concepts were generated. In order to conduct a customer survey at the later stage, CAD (Computer Aided Design) models of all 5 designs as well as 'Mary Biscuit' were created using SolidWorks software.

Figure 4-21. Some sketches of the 15 biscuit container design concepts
(designed by Ms. Yee Shy Huey, School of MAE, NTU)

The first design: 'Mushy'

The first design, 'Mushy' (see Figure 4-22), is a marshmallow-shaped biscuit container with matte surface. The internal surface of Mushy is in brown colour and suggests the container is filled with chocolate, thereby increasing users' appetite. An image of two ants heading towards the 'chocolate overflow' forms a design highlight against the white external surface. The intention of the design highlight is to make users feel curious and, therefore, encouraged to investigate the inside of 'Mushy'. The snap-fit lid is easy to open. Additionally, there is sweet scent on the external surface of the lid. Users may select a scent

they like for the ‘Mushy’ when purchasing. The sweet scents available include caramel, chocolate, vanilla and honey.

Figure 4-22. The first design: ‘Mushy’ (Chen et al., 2015b)

Figure 4-23. The second design: ‘Passion’ (Chen et al., 2015b)

The second design: ‘Passion’

The second design, ‘Passion’ (see Figure 4-23), is an orange-shaped biscuit container with matte surface. The matte surface resembles this biscuit container to a real orange. The container comprises a tissue paper chamber and six compartments that can hold various types of cookies. The transparent lid allows

users to view the cookies inside the container without opening it. As the white arrow shows, users can rotate the compartment around the tissue paper chamber to search for cookies they desire. Each of the individual compartments can be easily removed by simply lifting it up. Both biscuit container lid and tissue paper chamber lid are snap-fit. The tissue paper chamber lid is further customized with a fruit scent.

The third design: 'Desire'

The third design, 'Desire' (see Figure 4-24), is a snap-fit container made of brown matte plastics and shaped like a piece of chocolate. On its top is a figure of stickman, which is also a tissue paper container. The happy and bright smile on the stickman may cheer users up with some positive emotions. Users can play with the stickman as they and their companions interact with one another. The tissue paper container offers a choice of two scents: chocolate and milk. A temporary waste storage, hidden at the bottom of the container, is designed for users to discard their waste easily and conveniently.

Figure 4-24. The third design: 'Desire' (Chen et al., 2015b)

Figure 4-25. The fourth design: 'Sharkie' (Chen et al., 2015b)

The fourth design: 'Sharkie'

The fourth design, 'Sharkie' (see Figure 4-25), is a shark-shaped biscuit container with white colour and glossy surface. It is a screw lock container that offers several functional features. Users can estimate the level of cookies inside 'Sharkie' through the transparent eyes. The mouth of 'Sharkie' is a tissue paper holder. An inbuilt cutter at the fin helps users to open food packaging when needed. As shown in Figure 4-25, users can slide the food packaging material downward through the cutter to create a small opening. The cutter is built into the fin to ensure safety of younger users such as children. The slit is designed narrow enough to avoid children putting their fingers in. The scented fin comes with a variety of scents for users to choose, including fruits, sweet, mint, coffee, perfume, etc.

Figure 4-26. The fifth design: 'FreshMint' (Chen et al., 2015b)

The fifth design: 'Fresh Mint'

The fifth design, 'Fresh Mint' (see Figure 4-26), is a tooth-shaped biscuit container with glossy surface. It is a snap-fit container. There is a toothpaste-shaped and mint-scented tissue paper container on the top of the design. The intention is to educate users. When users clean their lips with tissue paper after eating, the mint smell may help remind them to brush their teeth.

The sensory design features

In order to compare the 'Mary Biscuit' with these design concepts generated, the CAD model of 'Mary Biscuit' was also created (see Figure 4-27). The representative sensory design features of the 6 biscuit container designs were summarized in Table 4-7.

Figure 4-27. The CAD model of 'Mary Biscuit' (Chen et al., 2015b)

Table 4-7. The main sensory design features of the 6 biscuit container designs
(adapted from Chen et al., 2015b)

Biscuit Container Designs
Sensory Design Features	Mushy	Passion	Desire	Sharkie	Fresh Mint	Mary Biscuit
Visual	Marshmallow shape, matte surface, ants, overflow chocolate, brown colour internal surface, snap-fit lid	Orange shape, matte surface, tissue paper chamber, compartment s, transparent side of compartment, snap-fit lid	Chocolate shape, matte surface, stickman-shaped tissue paper container, temporary waste storage, snap-fit lid	Shark shape, glossy surface, transparent eyes, inbuilt cutter, screw lock lid	Tooth shape, glossy surface, toothpaste-shaped tissue paper container, snap-fit lid	Pillow-shaped container, biscuit-shaped lid, matte icy surface, translucent container, snap-fit lid
Tactile	Matte surface, snap-fit lid	Matte surface, snap-fit lid	Matte surface, snap-fit lid	Glossy surface, screw lock lid	Glossy surface, snap-fit lid	Matte surface, snap-fit lid
Olfactory	Sweet scent (selectable)	Fruit scent (selectable)	Scent (selectable)	Scent (selectable)	Mint scent (selectable)	Vanilla scent
Auditory	Snap-fit lid	Snap-fit lid	Snap-fit lid	Screw lock lid	Snap-fit lid	Snap-fit lid

4.3 The third stage

4.3.1 Methodology

The main purpose of the third stage of the case study is to investigate the potential user experience, compare design concepts, and generate a more consumer-focused design. Hence, a customer survey was conducted to evaluate the 6 design concepts: ‘Mushy’, ‘Passion’, ‘Desire’, ‘Sharkie’, ‘Fresh Mint’ and ‘Mary Biscuit’, and to acquire potential user experience. Four (4) participants were invited to go through a pilot study and 33 participants (Mean age =23.375

years, age range: 19–26 years; 17 female & 16 male) were invited to complete the survey. The recommendation to them was that they use their first thought answer to complete the survey. To avoid bias, none of the participants at the third stage were involved in the first stage of the case study.

The survey was presented using PPT (Microsoft PowerPoint) slides. It consisted of two major parts, viz. individual evaluation and comparison evaluation. In the individual evaluation, participants evaluated the design concepts one by one and they were told not to compare the 6 biscuit containers. The sequence of the biscuit containers appearing in the survey is randomised to reduce bias. The first part of the survey, i.e., individual evaluation, covered the following 6 aspects:

- (1) Introduction of the main concept and the design features of the biscuit container design;
- (2) Evaluation on the appearance, functional experience and emotional experience using a 5–point scale;
- (3) Decision making on the preferred scents (olfactory design features);
- (4) Decision making on the preferred usage occasions;
- (5) Selection of attractive sensory design features (listed in Table 4-7) and providing reasons; and
- (6) Extra comments and feedback.

During the second part of the survey, i.e., comparison evaluation, participants compared all six biscuit containers and ranked them based on their functional experience, emotional experience and willingness to buy. In addition, participants' attitudes toward the importance of different criteria that may affect their user experience and purchasing decision were also consulted. This result

can help designers to set weights for different aspects of user experience. In doing so, the user evaluation collected can be more reliable. In addition to the survey, the Pugh Matrix is further carried out to assist designers choose the final design concept in section 4.3.3.

4.3.2 Results and discussions

As illustrated in the case study, sometimes designers have to conduct user or customer research while the design concepts are not mature and physical prototypes are yet to be built. In the case study, the six designs were introduced and presented by PPT slides. Similar to virtual shopping, the sensory experiences are not complete (Citrin, et al., 2003) and users are able to only interact with the product through limited sensory modalities (i.e., relies mainly on visual experience). However, it is believed that the close interrelations and interactions among senses may help compensate for the absence of some stimuli to a certain extent (even though it is impossible to fully compensate or replace). For example, the auditory information can be used to improve the visual or tactile perceptions (Durlach & Mavor, 1995; Klatzky, et al., 2000; Kunkler-Peck & Turvey, 2000). Peck & Childers (2003) used written descriptions and visual depictions of products to help people acquire tactile information. Thus, designers can still acquire valuable potential user experience concerning different aspects of experience if enough information is provided to the users. As shown in Figure 4-28, one advantage of PPT slides is its convenience and flexibility to present the designs with images and textual descriptions.

Figure 4-28. Samples of PPT slides in the customer survey (Chen et al., 2015b)

To better present the results, the following discussions are divided into 6 issues.

A. The importance of criteria

Instead of averaging all criteria, the study takes individual differences into consideration by consulting participants' attitudes towards the importance of different criteria, i.e., appearance, functionality, emotional experience, and scent, that may affect their experience and purchasing decision.

A within subject ANOVA (two-factor without replication) was conducted to compare the effect of criteria on user experience and purchasing decision. It is found that there are no significant individual differences [$F(32, 96) = 0.753$, $p\text{-value} = 0.8176$] between participants. However, the differences on criteria are significant [$F(3, 96) = 109.475$, $p\text{-value} = 7.19\text{E-}31$].

It is possible that the participants shared similar attitudes toward the criteria for this kind of product type – biscuit container. On average, ‘functionality’ is chosen as the most important criterion, followed by ‘appearance’, ‘emotional experience’, and then ‘scent’.

B. Initial user experience

Table 4-8. The average ratings of user evaluation during the individual evaluation (adapted from Chen et al., 2015b)

Appearance	Mushy	Passion	Desire	Sharkie	Fresh Mint	Mary Biscuit	P-value
Pleasant	2.65	2.85	3.13	3.05	2.44	2.65	<i>0.05089</i>
Attractive	2.85	2.84	3.38	3.28	2.71	2.57	0.00299
Modern	2.78	2.98	3.41	3.28	3.06	2.54	0.00395
Interesting	2.80	2.90	3.40	3.21	2.92	2.63	0.02838
Cute	2.88	2.87	3.48	3.24	2.81	2.55	0.00186

Function	Mushy	Passion	Desire	Sharkie	Fresh Mint	Mary Biscuit	P-value
Practical	3.56	3.27	3.91	3.91	3.40	3.10	0.00261
Durable	3.73	3.66	3.12	3.68	3.35	3.35	0.04447
Safe	3.89	3.47	3.92	3.65	3.57	3.75	<i>0.36022</i>

Emotion	Mushy	Passion	Desire	Sharkie	Fresh Mint	Mary Biscuit	P-value
Happy	2.45	2.52	2.71	2.66	2.26	2.35	<i>0.4364</i>
Inviting	2.46	2.44	2.83	2.65	2.23	2.16	<i>0.0811</i>
Active	2.22	2.24	2.63	2.52	2.22	2.01	<i>0.1213</i>
Surprise	2.40	2.51	2.86	2.81	2.49	2.08	0.0161
Satisfied	2.42	2.29	2.78	2.73	2.34	2.19	<i>0.0730</i>
Comfort	2.40	2.43	2.70	2.53	2.23	2.31	<i>0.5124</i>

After viewing and getting to know each design concept, participants were asked to evaluate the product and its potential experience with their first thought response during the individual evaluation. Initial user experience is acquired by three main aspects. First, participants’ visual experience with product appearance was acquired. As shown in the first part of Table 4-8, the

design concept 'Desire' has the highest average ratings compared to the rest, followed by 'Sharkie', which is relatively close to 'Desire'.

Second, the average ratings of functional experience evaluation are shown in the second part of Table 4-8. Different design concepts have no significant effect on the criterion 'safe' but they do have effect on the criteria 'practical' and 'durable'. Overall, 'Desire' and 'Sharkie' were evaluated as being the most practical function. 'Mushy', 'Sharkie' and 'Passion' were more durable amongst all the biscuit containers. The safety of 'Desire' and 'Mushy' were also slightly higher compared to the rest.

Third, the evaluation of emotional experience is shown in the last part of Table 4-8. The results indicate that the different designs of biscuit containers have effects on the 'surprise' criterion and may have effects on the criteria of 'inviting' and 'satisfied'. Again, 'Desire' and 'Sharkie' tend to have the highest ratings for all emotional experience evaluations.

C. Individual differences in olfactory experience

During individual evaluation, participants chose their preferred type of scents for each design. The result suggested obvious individual differences in personal olfactory habits. For those participants who did not appreciate scents as an attractive design feature, they chose 'no scent' for most of the designs. For those who enjoyed olfactory experience, they tended to have their own preferred type of scent for different designs. In addition, visual design features tended to have an influence on participants' decision making on the scents. For example, for the design 'Desire' which is shaped and coloured to make a direct link to food – chocolate, 14 participants chose the scent to be chocolate flavour. As for the design 'Fresh Mint' which resembles tooth and toothpaste in shape

and colour, 18 participants chose the scent to be mint. As for the design ‘Sharkie’ which is not shaped to resemble food, most participants chose not to have a scent.

D. Design concepts and their suitable usage occasions

During individual evaluation, participants chose their preferred usage occasions when they liked to be using the biscuit container. Corresponding to the first stage of the case study, the usage scenarios included both daily use occasions and special events occasions.

Table 4-9. Sum of participants’ decision making on the preferred usage occasions (adapted from Chen et al., 2015b)

Biscuit Container		Mushy	Passion	Desire	Sharkie	Fresh Mint	Mary Biscuit
Daily Use Occasions	Breakfast <i>Alone</i>	10	7	11	11	13	12
	Breakfast <i>with Family</i>	9	14	12	12	12	12
	Afternoon tea <i>Alone</i>	14	9	14	14	16	15
	Afternoon tea <i>with Family</i>	15	17	15	14	12	12
Sum of Daily Use Occasions		48	47	52	51	53	51
Special Events Occasions	Festive seasons <i>with Companion</i>	17	26	15	15	7	11
	Exam <i>Alone</i>	9	9	16	16	17	12
	Movie marathon <i>with Companion</i>	11	5	13	12	10	10
	Party <i>with Companion</i>	14	17	16	14	11	9
	Outdoor activities (e.g., picnic) <i>with Companion</i>	13	15	11	17	8	10
Sum of Special Events Occasions		64	72	71	74	53	52
Sum of all Usage Occasions		112	119	123	125	106	103

Table 4-9 shows the accumulative total number of times each design concept and each usage scenario are chosen. The information regarding the

design concepts and their suitable usage occasions is valuable for not only designers or product managers, but also for customer segmentation or marketing department. For example, if a company is keen to develop a product or a kind of experience for some specific scenarios or target contexts, this kind of information can help in decision making on the necessary trade-off. A company can also explore new usage contexts for a novel product and its experience and then plan for its marketing strategies, e.g., highlight the usage scenario in the advertisement. For instance, if a company wishes to launch a biscuit container during Chinese New Year, the design concept 'Passion' can be a good choice as it shows the highest score for the 'festive seasons' occasions. However, if a company intends to identify more possible usage occasions to increase its share of consumers, the design concepts 'Desire' and 'Sharkie' are ideal as they are suitable for a larger number of usage occasions whether for daily use or special events. From a different point of view, if a company is launching the product 'Passion', it can highlight its suitability for special events such as festival seasons, e.g., compartments to contain and display different kinds of cookies and sweets, which can elicit a positive feeling of sharing happiness. Designers can also find out which design features can be prominently used and which may be unsuitable for certain usage occasions. There is much that one can learn and benefit from by considering such contextual factors during user experience acquisition.

E. The comparison evaluation

During the comparison evaluation, participants compared all six design concepts on three main aspects. First, participants compared the concepts in terms of their functional benefits. As shown in the first part of Table 4-10,

different design concepts have significant effects on the functional experience evaluations. ‘Desire’ and ‘Sharkie’ are the most practical designs while ‘Mushy’ and ‘Mary Biscuit’ are the most durable and safe designs.

Second, the average ratings of emotional experience evaluation are shown in the second part of Table 4-10. The result suggests that the designs of biscuit containers do affect emotional experience evaluations. Exhibiting similar results to the individual evaluation, ‘Desire’ and ‘Sharkie’ obtained the highest ratings for all aspects of emotional experience.

Third, participants’ willingness to purchase the biscuit containers without considering cost-related factors was consulted during the comparison evaluation. This is regarded as to provide a situation closer to the real world, i.e., on the market. As shown in the last part of Table 4-10, the effects of the design concepts on the participants’ purchasing decisions were significant. ‘Desire’ and ‘Sharkie’ would be purchased by most of the participants, followed by ‘Mushy’ and ‘Passion’.

Table 4-10. The average ratings of user evaluation during the comparison evaluation (adapted from Chen et al., 2015b)

Function	Mushy	Passion	Desire	Sharkie	Fresh Mint	Mary Biscuit	<i>P-value</i>
Practical	55.01	53.69	70.72	73.36	46.15	46.55	8E-06
Durable	68.58	46.23	57.05	64.37	44.37	69.12	3E-04
Safe	79.31	59.92	62.72	45.36	50.26	72.33	9E-07

Emotion	Mushy	Passion	Desire	Sharkie	Fresh Mint	Mary Biscuit	<i>P-value</i>
Happy	32.57	35.94	55.27	51.38	32.05	30.72	4E-07
Inviting	37.90	38.43	53.44	51.37	29.77	31.65	4E-05
Active	36.09	41.85	52.29	52.70	39.05	28.23	1E-04
Surprise	29.72	41.85	56.16	55.32	37.47	26.92	4E-09
Satisfied	35.59	38.94	55.37	52.47	31.52	32.26	1E-05
Comfort	38.80	40.06	50.48	49.30	28.07	38.29	1E-03

Willingness to purchase	Mushy	Passion	Desire	Sharkie	Fresh Mint	Mary Biscuit	<i>P-value</i>
	59.03	58.09	81.24	73.15	49.24	48.67	1.02E-06

F. Qualitative information

Besides the quantitative data discussed above, qualitative feedback was also collected. From the varied aspects of user experience, designers can gain a better understanding of participants' thoughts. Qualitative information can help extend the feedback as the information is not restricted to the available choices of the answers. It also provides a chance for designers to discover customers' possible doubts and queries, which can help designers to improve the designs, thus creating a more positive experience. For example, participants may query the ease of cleaning the brown internal surface of 'Mushy', or whether 'Passion' might topple too easily when kids handle it, or whether the level of food content would always be visible through Sharkie's eyes. Participants would also comment on aspects of the designs. One comment could be about the affective value of the overflow chocolate feature of 'Mushy' which may stir up curiosity and longing, or on the functional value of the temporary waste storage of 'Desire' during outdoor use; and the sensory design features of the mint scent of 'Fresh Mint', which may elicit in users the feeling of freshness that would remind them to brush their teeth. Furthermore, valuable suggestions can be acquired in the process as well. For instance, commenting on the design 'Sharkie', one participant suggested changing the direction the cutter would cut through the food packaging -- by sliding the package upwards instead of downwards as this would then avoid the contents spilling out during the cutting process.

In addition, qualitative information can help designers to assess how well a participant is able to build a mental model of a design concept in his/her mind, particularly in a virtual situation where users do not get to physically interact

with the products. It can reveal how well a participant can imagine a product as well as his/her potential user experience. In fact, participants may give vivid comments when they are motivated to imagine user experience. For example, one participant noted *“the whole appearance of the stickman makes people happy especially when it looks as if you are trying to steal his food. The tissue paper storage area at the inner section is an added surprise – [Participant 1 – Affective (happy, surprise)]”* while evaluating ‘Desire’.

4.3.3 The final design concept

Based on the user experience and evaluation acquired above, a final design concept was chosen using the Pugh Matrix (PM) and subsequently revised. The Pugh Matrix is a decision–support tool that can facilitate the comparison of a number of design concepts based on certain criteria (Burge, 2009). The survey results is further organized into Table 4-11 using the Pugh Matrix for easy comparison. The existing product – Mary Biscuit – is selected as the ‘baseline’, which is scored as ‘0’ against all of the criteria. The other five design concepts are then compared against Mary Biscuit with respect to each of the criteria. If a design concept is

- much better than the baseline for a criterion, a “+2” is scored
(while the average score is 0.5 larger than the baseline in individual evaluation, and 10 larger than the baseline in comparison evaluation);
- better than the baseline for a criterion, a “+1” is scored;
- the same as the baseline for a criterion, a “0” is scored;
- worse than the baseline for a criterion, a “–1” is scored;
- much worse than the baseline for a criterion, a “–2” is scored
(while the average score is 0.5 less than the baseline in individual evaluation, and 10 less than the baseline in comparison evaluation).

Table 4-11. The Pugh Matrix of the six biscuit container designs

Biscuit Container Designs
		Mushy	Passion	Desire	Sharkie	Fresh Mint	Mary Biscuit (baseline)
Criteria							
(Results from Individual Evaluation)							
Appearance							
1	Pleasant	0	+1	+1	+1	-1	0
2	Attractive	+1	+1	+2	+2	+1	0
3	Modern	+1	+1	+2	+2	+2	0
4	Interesting	+1	+1	+2	+2	+1	0
5	Cute	+1	+1	+2	+2	+1	0
Function							
6	Practical	+1	+1	+2	+2	+1	0
7	Durable	+1	+1	-1	+1	0	0
8	Safe	+1	-1	+1	-1	-1	0
Emotion							
9	Happy	+1	+1	+1	+1	-1	0
10	Inviting	+1	+1	+2	+1	+1	0
11	Active	+1	+1	+2	+2	+1	0
12	Surprise	+1	+1	+2	+2	+1	0
13	Satisfied	+1	+1	+2	+2	+1	0
14	Comfort	+1	+1	+1	+1	-1	0
Regarding Usage Occasions							
15	Fit more Daily Use Occasions	-1	-1	+1	0	+1	0
16	Fit more Special Events Occasions	+1	+1	+1	+1	+1	0
(Results from Comparison Evaluation)							
Function							
17	Practical	+1	+1	+2	+2	-1	0
18	Durable	+1	-2	-2	-1	-2	0
19	Safe	+1	-2	-1	-2	-2	0
Emotion							
20	Happy	+1	+1	+2	+2	+1	0
21	Inviting	+1	+1	+2	+2	-1	0
22	Active	+1	+2	+2	+2	+2	0
23	Surprise	+1	+2	+2	+2	+2	0
24	Satisfied	+1	+1	+2	+2	-1	0
25	Comfort	+1	+1	+2	+2	-2	0
Other							
26	Willingness to purchase	+2	+1	+2	+2	+1	0
	Total +2	+2	+4	+34	+32	+6	0
	Total +1	+23	+20	+6	+6	+12	0
	Total -1	-1	-2	-2	-2	-7	0
	Total -2	-0	-4	-2	-2	-6	0
	Total Score	+24	+18	+36	+34	+5	0

The final results suggest that ‘Desire’ obtains the highest score, followed by ‘Sharkie’, ‘Mushy’, ‘Passion’, ‘Fresh Mint’ and then the existing product ‘Mary Biscuit’.

Figure 4-29. The prototype of the final design, ‘Desire’ (Chen et al., 2015b)

Accordingly, the design of ‘Desire’ was revised and improved. Based on the customer requirements and comments collected, opening the temporary waste storage compartment was changed to a sliding action – for more convenient of usage. This gentler action would minimise biscuits crumbling as the waste storage was opened. Subsequently, a physical working prototype was built as shown in Figure 4-29.

4.4 General discussion

The application of the CMSES and SCS can be readily tailored to meet different purposes and needs. A company should first clarify the goal or special interests of its design project. For the case study, the targeted user group was the youth segment, and the product type of interest was the biscuit container. The design team was keen to get a deeper, more detailed and comprehensive understanding of user experience so as to create more consumer-focused products. As demonstrated at the first stage of the case study, the ‘context-based multi-sensory experience acquisition’ is a promising approach to help designers examine, investigate, and optimise user experience in a more dedicated and robust manner.

The approach takes individual differences into consideration when tackling multiple contextual factors. This is to ensure the experiential knowledge acquired can fit into a user’s real situation and is thus more valuable and usable. A company can decide how much users can be allowed to contribute to the contextual settings of usage scenarios which are in turn used in the user involvement studies. In the case study, the design team relied on an easy and quick way by providing several usage scenarios and participants get to choose their ideal one(s) to experience the product. Among the benefits of this approach are smaller budgets involved, less time consuming, and no extra training is required for the user side. Nevertheless, any company that promotes innovation and creativity is in the position to allow users more opportunity and freedom to decide on their customized scenarios. In doing so, design teams can be better inspired as to how a product can be ‘played’ and at the same time, the

marketing department can explore more potential usage scenarios for advertising and other marketing efforts.

Most users experience a product through all the physical senses and it is good for designers deal with inherently complex user experience in a natural way right from the beginning. Applying multi-sensory experience acquisition is akin to using a magnifier to examine user experience -- no sensory aspect will be missed and a more complete exploration of user experience is achieved. For example, design teams can discuss the sensory experience of any particular sense in greater detail – to identify possible problems caused by a stimulus, and to seek the cause and effect of both positive and negative experience so as to explore potential opportunities for ‘multi-sensory experience design’. Meanwhile, design teams can probe and examine how the different sensory design features could affect user experience while working together to ensure the design concept produces a natural, logical, and pleasing overall multi-sensory experience. On top of this, designers have to ascertain that design concepts can fit into the targeted usage scenarios after the conceptualization stage. Design concepts thus created can bring users the most long-lasting positive, hedonic, and rich multi-sensory experience. Design concepts generated at the second stage of the case study tended to have better user evaluation than the original design for the youth segment as discussed at the third stage of the case study. In this sense, the proposed ‘context-based multi-sensory experience design’ approach can also strengthen the experience design.

Given that the knowledge regarding customers’ personal sensory preference, sensory habits and ideal usage contexts can be acquired, a company can therefore plan better for its marketing and design strategies as well. Yet the

application can still be very flexible depending on the project focus. One can emphasize more on the contextual factors and individual differences. For example, if a company wishes to develop a product targeting at some specific segments (e.g., the elderly, the ‘soho’, young parents or athletes), it may start by unearthing which kinds of usage contexts are the most popular for the different user groups, followed by deciding on the design and marketing strategy. Researchers can also manipulate some contextual factors in the SCS or provide some rules for co-building scenarios with users to investigate some special issues. For instance, a company may give users a premise that the time is five years into the future and users have to build up their imagined future usage contexts. One can give greater focus to the multi-sensory experience and individual differences. For example, if a company wishes to implement a ‘mass customization’ strategy that would help expand its customer segments, it can make good use of the knowledge regarding users’ individual sensory preference. As shown in the case study, participants tend to have stronger individual differences on the olfactory and auditory experiences. Accordingly, designers can provide more diverse sensory design features (e.g., more choices on the scents for such biscuit container design) to satisfy different customer segments while simultaneously controlling manufacturing costs.

Admittedly, the study may consume more time and incur higher costs because it seeks more and detailed input from the customer domain. In addition, this concept should be carried out at the very onset of PDD in order to maximise the benefits. However, it is a worthy endeavour and investment for a company to undertake, especially as understanding the consumer’s experience has grown in increasing importance in this highly competitive era.

Chapter 5

The Case Study of Automated Teller Machine Design

This case study illustrates a user involvement study – from the preparation stage to the execution and analysis stages – that utilises the SCS and UCF. In this study, the designers aim to investigate into automated teller machine (ATM) user experience from a contextual level.

5.1 Preparation stage

Identify user group and plan for user participation

It is assumed that the project plan has identified a certain target user group and the project manager possesses some basic background information regarding the target users. To apply the SCS, designers need to construct a co-built system to guide users in determining their ideal usage contexts. The content and representation of contextual factors depends largely on the level-of-freedom accorded to the co-build process. To ultimately achieve a high level-of-freedom for the system, it is optimum to start from a lower level and progressively raise the level. In the case study, the target users between 20 ~ 30 years old and for whom the ATM is a commonly used appliance were considered. Hence, it was highly possible for the users to recall a usage context in which they would usually use such appliance. Therefore, the level-of-freedom was set at ‘medium’ denoting that the users could make decisions on each contextual factor of the usage context.

The overall flow of the case study is shown in Figure 5-1. Firstly, a pre-study was conducted to gather users’ ATM usage contexts, usage habits and

behaviour (including the purposes, situations, routines in terms of place and time of day when they would use an ATM). A total of 48 participants (26 females and 22 males) were invited to complete the survey.

Figure 5-1. Overall flow of the case study

After that, database construction is executed. On completion of this step, a UCF for preparation stage would be completed. Subsequently, based on the UCF, an interactive co-built webpage is constructed, which is the third step of the flow. The forth step is to carry out a pilot study to test the webpage and the overall user involvement. The fifth step is the main experiment which is further introduced in Section 5.2. Section 5.3 then describes the sixth step of the flow – result analysis and discussion. Finally, Section 5.4 summarises the case study with a brief conclusion.

The details of the second step, database construction, are further presented as follow. Based on the pre-study, designers examined the results and identified some key contextual factors. In the case study, the key contextual factors of usage context (UC) were identified as time, event, location, companion, and other external factors. Each factor was assigned corresponding parameters. In some cases, a factor may have different layers of parameters. For example, two levels of time, namely the day – “weekday / weekend” and the time – “morning / noon / afternoon / evening / night” were used in this case. Next, this relevant

information was arranged into a UCF (user context form), as shown in Table 5-

1.

Table 5-1. The UCF in the ATM case study (preparation stage, part A)

Project Name: ATM design												
Part A. Used for preparation stage: identify user group and plan for user participation (Planning)												
1 st level stakeholders: Project manager;												
2 nd level stakeholders: Design researchers, Designers;												
3 rd level stakeholders: Programmer, Graphic Designers												
#	Users' Background Info.				Multiple Contextual Factors							Notes
	Target User Group				Preset Usage Context Settings							
	Gender	Age	Career	Income	Time level 1	Event level 1	Event level 2	Time level 2	Location	Companion	External Factors	
	Male / Female	20 ~30	Students	Any	Weekday / Weekend	Indoor Activities / Outdoor Activities	A Total of 24 Activities	Morning/ Noon/ Afternoon / Evening/ Night	Totally 12 Locations	Alone / With Friends / With Family	Number of People in Queue: 0 / 1~3 / 4~6 / More than 7	
							on the way to school, on the way to office, on the way home, school hours, office hours, exercise, shopping, movie, lunch, dinner, tea break, project, indoor eating out, outdoor eating out, indoor sport activity, outdoor sport activity, visiting friends, religious activity, other indoors, park & garden, picnic, kite, beach, BBQ.		HDB (Public housing in Singapore, which is managed by the Housing and Development Board), supermarket, hawker & food centre, bank branch, shopping centre, convenience store, MRT station, bus interchange, campus, office & industrial building, park & garden, beach.

Figure 5-2. The sequence of contextual factors appearing in the co-built process

Subsequently, designers needed to decide on the co-built process, and how the process would guide the users to choose their ideal usage contexts in a manageable way. To keep the co-built process simple, users decided on one level of contextual factor at a time and then gradually completed the co-built usage context. The sequence of the contextual factors to be appeared was determined by considering the ways with which users could be more easily immersed into the scenario (see Figure 5-2).

Next, a decision on which way to present the co-built process was made. Various tools could be adopted to facilitate the interactions with users, (e.g., Microsoft PowerPoint, Adobe Flash, or interactive webpages). In this case study, an interactive webpage was employed to aid users in determining their ideal usage scenarios. Stakeholders must therefore include a programmer to set up the interactive webpage.

By applying the definition 4, definition 5, and formulas (7) to (9) provided in Chapter 3, the information from the previous step was then formulated into a more systematic format to facilitate this task.

Users' background information includes the users' gender (G), age (A), career (CA) and income (I). Mathematically,

$$U_{(ID)} = \cup (G, A, CA, I)_{(ID)}; \quad (5-1)$$

where the targeted user group is set as follows.

$$\begin{aligned} G_{(Targeted)} &= \{\text{Male (1), Female (2)}\}; A_{(Targeted)} = \{20 \sim 30\}; CA_{(Targeted)} \\ &= \{\text{Students}\}; I_{(Targeted)} = \{\text{Any}\} \end{aligned} \quad (5-2)$$

Usage context includes multiple contextual factors, namely time (T), event (E), location (L), companion (CO), and other external factors (EF). Mathematically,

$$UC_{(ID)} = \cup (T, E, L, CO, EF)_{(ID)} \quad (5-3)$$

In addition, these contextual factors may include factors from the second level and can be adjusted accordingly. For example, 'time (T)' can be divided into day and time, mathematically,

$$T = \cup (T_{(i)}, T_{(j)}) = T_{(i,j)}; \text{ where} \quad (5-4)$$

$$T_{(i)} = \{i \mid i = 1, 2\}; \text{ where } 1 = \text{weekday}, 2 = \text{weekend}; \quad (5-5)$$

$$\begin{aligned} T_{(j)} &= \{j \mid j = 1 \sim 5\}; \text{ where } 1 = \text{morning}, 2 = \text{noon}, 3 = \text{afternoon}, \\ &4 = \text{evening}, 5 = \text{night}; \end{aligned} \quad (5-6)$$

For example, the $T_{(13)}$ represents the weekday afternoon.

In the case study, 'event (E)' also included two levels – the main attribute (indoor, outdoor) and the related events (listed below).

$$E = \cup (E_{(k)}, E_{(l)}) = E_{(k,l)}; \text{ where} \quad (5-7)$$

$$E_{(k)} = \{k \mid k = 1, 2\};$$

$$\text{where } 1 = \text{indoor activities}, 2 = \text{outdoor activities}; \quad (5-8)$$

$$\begin{aligned} E_{(l)} &= \{l \mid l = 1 \sim 24\}; \text{ where } 1 = \text{on the way to school}, 2 = \text{on the way to} \\ &\text{office}, 3 = \text{on the way home}, 4 = \text{school hours}, 5 = \text{office hours}, 6 = \end{aligned}$$

exercise, 7= shopping, 8= movie, 9= lunch, 10= dinner, 11= tea break, 12= project, 13= indoor eating out, 14= outdoor eating out, 15= indoor sport activity, 16= outdoor sport activity, 17= visiting friends, 18= religious activity, 19= other indoors, 20= park & garden, 21= picnic, 22= kite, 23= beach, 24= BBQ. (5-9)

Other contextual factors include only one level. ‘Location (L)’ includes 12 choices and can be presented as follows.

$L_{(m)} = \{m \mid m = 1 \sim 12\}$; where 1= HDB (Public housing in Singapore, which is managed by the Housing and Development Board), 2= supermarket, 3= hawker & food centre, 4= bank branch, 5= shopping centre, 6= convenience store, 7= MRT station, 8= bus interchange, 9= campus, 10= office & industrial building, 11= park & garden, 12= beach. (5-10)

The design team is also interested in how ‘companion (CO)’ and ‘external factors (EF)’ regarding how many people queue in line may influence users’ behaviour.

$CO_{(n)} = \{n \mid n = 1, 2, 3\}$;

where 1= alone, 2= with friends, 3= with family. (5-11)

$EF_{(o)} = \{o \mid o = 1 \sim 4\}$;

where 1= no people in queue, 2= 1~3 people in queue, 3= 4~6 people in queue, 4= more than 7 people in queue. (5-12)

Consequently, the formula can be revised as follows:

$$UC_{(ID)} = \cup (T, E, L, C, EF)_{(ID)}$$

$$= \cup (T_{(ij)}, E_{(kl)}, L_{(m)}, C_{(n)}, EF_{(o)})_{(ID)} \quad (5-13)$$

The programmer can then organize this information into the UCF, as shown in Table 5-2.

Table 5-2. The UCF in the ATM case study (preparation stage, part B)

Project Name: <u>ATM design</u>													
<u>Part B. Used for the preparation stage: identify user group and plan for user participation (Constructing)</u>													
Stakeholders: Programmer, Design researchers													
#	Users' Background Info.				Multiple Contextual Factors							Note	
	<i>Target User Group (U)</i>				<i>Preset Usage Context Settings (UC)</i>								
	Gender	Age	Career	Income	Time level 1	Event level 1	Event level 2	Time level 2	Location	Companion	External Factors		
	<i>G</i>	<i>A</i>	<i>CA</i>	<i>I</i>	<i>T_(i)</i>	<i>T_(j)</i>	<i>E_(k)</i>	<i>E_(l)</i>	<i>L_(m)</i>	<i>CO_(n)</i>	<i>EF_(o)</i>		
	<u>The Formula Level 1</u> $U_{(ID)} = \cup (G, A, CA, I)_{(ID)}$				<u>The Formula Level 1</u> $UC_{(ID)} = \cup (T, E, L, CO, EF)_{(ID)}$ $= \cup (T_{(ij)}, E_{(kl)}, L_{(m)}, CO_{(n)}, EF_{(o)})_{(ID)}$								
	<u>The Formula Level 2</u> Where $G_{(Targeted)} = \{ \text{Male (1), Female (2)} \}$ $A_{(Targeted)} = \{ 20 \sim 30 \}$ $CA_{(Targeted)} = \{ \text{Students} \}$ $I_{(Targeted)} = \{ \text{Any} \}$				<u>The Formula Level 2</u> Where $T_{(i)} = \{ i \mid i = 1, 2 \}$; where 1= weekday, 2= weekend; $T_{(j)} = \{ j \mid j = 1 \sim 5 \}$; where 1= morning, 2= noon, 3= afternoon, 4= evening, 5= night; $T_{(ij)} = \{ i \mid i = 1, 2 ; j \mid j = 1 \sim 4 \}$ $E_{(k)} = \{ k \mid k = 1, 2 \}$; where 1= indoor activities, 2= outdoor activities ; $E_{(l)} = \{ l \mid l = 1 \sim 24 \}$; where 1= on the way to school, 2= on the way to office, 3= on the way home, 4= school hours, 5= office hours, 6= exercise, 7= shopping, 8= movie, 9= lunch, 10= dinner, 11= tea break, 12= project, 13= indoor eating out, 14= outdoor eating out, 15= indoor sport activity, 16= outdoor sport activity, 17= visiting friends, 18= religious activity, 19= other indoors, 20= park & garden, 21= picnic, 22= kite, 23= beach, 24= BBQ. $L_{(m)} = \{ m \mid m = 1 \sim 12 \}$; where 1= HDB, 2= supermarket, 3= hawker & food centre, 4= bank branch, 5= shopping centre, 6= convenience store, 7= MRT station, 8= bus interchange, 9= campus, 10= office & industrial building, 11= park & garden, 12= beach. $CO_{(n)} = \{ n \mid n = 1, 2, 3 \}$; where 1= alone, 2= with friends, 3= with family. $EF_{(o)} = \{ o \mid o = 1 \sim 4 \}$; where 1= no people in queue, 2=1~3 people in queue, 3= 4~6 people in queue, 4= more than 7 people in queue.								

Based on the UCF, programmer worked with graphic designers to complete the co-built webpage. In other words, the third step, i.e. user interface design (see Figure 5-1), can be carried out accordingly. In the case study, Ms. Ivy Yau, a student of the NTU/MAE Design Stream, contributed to the design of interactive webpages, which came with two main webpage types as follows.

1. Contexts selection page, where participants chose the contextual settings of an ATM (as shown on the left side in Figure 5-3).

2. Scenario presenting page, which summarized all the contextual settings chosen by a participant. This page can enhance users' imagination of the scenarios (as shown on the right side in Figure 5-3).

Figure 5-3. Sample screenshots of the interactive webpage for co-building a usage scenario

As shown in the flow in Figure 5-2, the webpage could serve to guide users as they made their choice one by one for each contextual factor. The chosen parameters appeared immediately on the next page so that users could have instant feedback and thus be more easily immersed in the usage scenario. For example, after a user chose the time 'at night', this decision was instantly presented together with the other previously chosen factors at the same time – 'shopping (event) at night (time)', as shown in Figure 5-3. In this manner, all

contextual factors were represented visually. This had the effect of facilitating the co-building process, making it more lively and generally helping users to quickly get immersed into the context. As a result, both users and designers alike were inspired and enthused.

Once the co-built process was completed, the researchers subjected the webpages to a number of trial runs to ensure that they were free of any programming bugs. Five participants were then invited to carry out a pilot study that aimed to ascertain whether users would be able to follow the system and successfully co-build a customized usage scenario.

5.2 Execution stage

User participation

During the formal user participation, the UCF can also be used to record the user's background and selected context settings, as shown in Table 5-3. As every parameter for each contextual factor is numbered, it is relatively straightforward and easy for designers to record the choices for each different participant. In addition, each scenario is consequently assigned a code, which further aids in the subsequent analysis.

Depending on the project plan, designers can make good use of the information gathered on individual differences with regard to a usage context. For example, understanding how individual differences affect users' ideal usage context and behaviour could help in customer segmentation and management, as well as for mass customization design. Furthermore, it is possible to investigate user experience in a more comprehensive way by discussing how the various contextual factors may affect user experience and evaluation. This

can be a value-adding process, especially when developing and designing from the contextual level.

Table 5-3. The UCF in the ATM case study (execution stage)

Project Name: <u>ATM design</u>												
Part C. Used for <u>execution stage</u> : record during user participation												
Stakeholders: Design researchers, Designers												
#	Users' Background Info.				Multiple Contextual Factors							Notes
	True User Record $U_{(ID)}$				Chosen Context Settings $UC_{(ID)}$							
	Gender	Age	Career	Income	Time level 1	Event level 1	Event level 2	Time level 2	Location	Companion	External factors	Scenario code
e.g.	2	20-30	Student	0-2000	2	1	6	2	2	2	3	2162223
1	...	...	...	...	...	...	...	...	...	...	...	...
2	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
N	...	...	...	...	...	...	...	...	...	...	...	...
	Where 1= male, 2= female				Where 1=week day, 2=week end	Where 1=indoor activities, 2=outdoor or activities	Where 1= on the way to school, 2= on the way to office, 3= on the way home, 4= school hours, 5= office hours, 6= exercise, 7= shopping, 8= movie, 9= lunch, 10= dinner, 11= tea break, 12= project, 13= indoor eating out, 14= outdoor eating out, 15= indoor sport activity, 16= outdoor sport activity, 17= visiting friends, 18= religious activity, 19= other indoors, 20= park & garden, 21= picnic, 22= kite, 23= beach, 24= BBQ.	Where 1=morning, 2=noon, 3=after noon, 4=even ing, 5=night	Where 1= HDB, 2= supermarket, 3= hawker & food centre, 4= bank branch, 5= shopping centre, 6= convenient store, 7= MRT station, 8= bus interchange, 9= campus, 10= office & industrial building, 11= park & garden, 12= beach.	Where 1= alone, 2= with friends, 3= with family	Where 1= no people in queue, 2=1~3 people in queue, 3= 4~6 people in queue, 4= more than 7 people in queue	

Guided by the plan drawn up earlier, 34 participants (17 male and 17 female, aged between 20 and 30 years old) were invited to contribute to the user involvement study. This was to be a three-stage experiment, namely ‘co-building of an ATM-usage scenario’, ‘experiencing and evaluating ATM designs’, and ‘questionnaire and interview’, as shown in Figure 5-4. The experiment was conducted in the Design & Human Factors Lab, School of Mechanical & Aerospace Engineering, Nanyang Technological University. The experiment venue is shown in Figure 5-5.

The data collection methods included both qualitative and quantitative methods. The process used is described as follows. The participants were first introduced to the overall process and the aims of the experiment, they were then asked to sign the declaration form. After providing their basic personal information, the participants took part in the three-stage experiment.

Figure 5-4. The three-stage experiment

Figure 5-5. The experiment venue

Table 5-4. Summary of the design principles applied

Design Principles		References	
Design Principle 1: Clear entry point			
<ul style="list-style-type: none">• A good ATM should provide a clear entry point for users to easily identify.• The entry point could be achieved by either colour or material differentiation.	<i>Fenko, et al., 2010; Lidwell, et al., 2010; Current ATM study</i>		
Design Principle 2: Centralize operational blocks			
<ul style="list-style-type: none">• Operational blocks should be arranged within certain area to minimize users’ attention transfer.• The operational blocks (incl., card reader, PIN pad, screen and money window) should be arranged within a certain area.	<i>Lidwell, et al., 2010; Current ATM study</i>		
Design Principle 3: Meet users’ expectation			
<ul style="list-style-type: none">• Users should be provided with a clear feeling on what the operational blocks are used for. This requires a harmonious combination of visual, auditory and tactile stimulus.	<i>Rebollar, et al., 2012; Schifferstein & Cleiren, 2005; Current ATM study</i>		
Design Principle 4: Provide feedbacks			
<ul style="list-style-type: none">• Sensory feedback should be provided at where attention is needed.• Visual and auditory feedback could be provided simultaneously.	<i>Zeelenberg & Bocanegra, 2010; Current ATM study</i>		
Design Principle 5: Accessibility to everybody			
<ul style="list-style-type: none">• The ATM design should be accessible to people with different conditions.• Information should be provided in multiple methods• Detectability; usability; simplification; error acceptable	<i>Lidwell, et al., 2010; Current ATM study</i>		
Design Principle 6: Security experience			
<ul style="list-style-type: none">• The ATM should be able to provide security feelings	<i>Current ATM study</i>		
ATM Design Concepts	Guard	Desk	Barrel
Design principles used	1, 3, 4, 6	2, 3, 4, 5	1, 2, 4, 5

In the first stage, participants co-built the customized ATM usage scenarios with the assistance of the Scenario Co-build webpage (Figure 5-3). During this, participants needed to verbally describe what they were doing and whatever

came to their minds, either thoughts or feelings, i.e., using the think aloud protocol (TAP). The interactive webpage guided participants in gradually building up their ideal usage scenarios. The results were visualized and one demonstration image of a scenario was shown to the participants.

Moving on to the second stage of experiment, the participants then experienced three different ATM designs by carrying out a representative and simple task – withdrawing money from ATM, based on the customized usage scenario. The ATM designs are created based on six design principles, which are presented in Table 5-4. The design details are shown in Figure 5-6 to Figure 5-8.

Regarding the first design – ‘Guard’ (see Figure 5-6), the outlook of the cover above with the projected light zone not only give a feeling of security, it also has a safety function that will detect any suspicious person behind the user and create an alert for the user. When there is nobody using the ATM, the light zone appears as green. When someone is using it, the area changes to red. The red area serves like a traffic light reminding people in the queue to stand and wait behind the red area. If someone steps into the red area, the ATM would generate both visual and auditory feedbacks to remind the current ATM user about the suspicious condition behind him or her. The control panel aims to provide convenient operations of the ATM. The card reader, PIN pad and money window are aligned along the central line of the ATM. This could reduce the users’ attention movement and keep the whole using process to be vertical. The card reader is designed with a flash light indicator behind to make it as the clear entry point towards the users.

Figure 5-6. The first ATM design concept – the ‘Guard’
(Designed and illustrated by Mr. Liu Bingda, a student of NTU/MAE Design Stream)

The second ATM design – “Desk” is shown in Figure 5-7. It is designed for people with both standing posture and sitting posture. With a forward angle of the screen and a leaned body, wheelchair users can approach and use the ATM in a more friendly and convenient way. The operation area, where users need to see and touch to complete tasks, is coloured for easy identification. In addition, both the PIN pad and money window areas have a light frame to indicate their positions as well as the conditions. Besides the visual feedback, there is also auditory feedback.

Figure 5-7. The second ATM design concept – the ‘Desk’
(Designed and illustrated by Mr. Liu Bingda)

3. The Barrel

- Universal design
- Anti-Peeking Pin Pad
- Visual and audio feedback
- Clear entry point
- Convenience table

Figure 5-8. The third ATM design concept – the ‘Barrel’

(Designed and illustrated by Mr. Liu Bingda)

The third design – “Barrel” (see Figure 5-8), unlike usual ATM design, delivers a gentle feeling with its round shape design. The small area in front served as a small table for users to put their small bags or drinks so that they

can operate the ATM hands free and more conveniently. The half-opened sphere structure on top of the ATM is the operation area, containing the card reader, PIN pad and screen. The sphere structure design can gather users' attention while maintaining their privacy. There are also general visual and auditory feedbacks during the operation (e.g. light and sounds to indicate where to put the card and where to collect money, etc).

These designs were presented using Microsoft PowerPoint (PPT) slides and projected on a screen. In the lab, participants can interact with the ATM freely (see examples in Figure 5-9). In practice, the second and third stages of the experiment were carried out as an iterative process. Participants viewed one design at a time, and evaluated it using the experience rating scale. After being presented with the first design, they were presented with the second design, and then the third. When all three designs had been evaluated, a participant was interviewed and answered a final questionnaire.

Figure 5-9. The participants interact with ATM projected

The questionnaire used was divided into two sections. The first section examined the participants' user experience and the second section examined how the scenario and contextual factors affected their experience. A summary of the questionnaire is shown in Table 5-5. The first section comprised three parts about the participants' overall experience, functional experience and

emotional experience with regard to each design. Similar questions for each design were completed separately as one design after another was viewed in turn. The questions were answered using a 7-point Likert scale (see samples in Figure 5-10).

Table 5-5. Summary of the questionnaire

Section 1 of the questionnaire (used in the 2 nd stage experiment)				
Part 1 : Overall Experience		Part 2 : Functional Experience		Part 3 : Emotional Experience
A. Overall operation process of cash withdrawal		B. Usability of the design concepts		C. Evaluation of seven emotions
A1. Smoothness	B1. Ease of identifying the inputs (card reader, pin pad)	B2. Ease of identifying the outputs (money window)	C1. Satisfied	C2. Pleasure
	B3. Convenience of using the layout	B4. Effects of the new pin pad arrangement	C3. Comfortable	C4. Confident
A2. Ease			C5. Calm	C6. Secure
			C7. Privacy	
Section 2 of the questionnaire (used in the 3 rd stage experiment)				
D. User experience (UX) & Scenarios		E. User experience & contextual factors		
Degree of effect of scenarios on UX	D1. Overall experience	E1. Effect of location on UX	E2. Effect of time of day on UX	E3. Effect of event on UX
	D2. Functional experience			
	D3. Emotional experience	E4. Effect of number of people in queue on UX	E5. Effect of companionship on UX	
	D4. Willingness to queue			

Overall Experience

(3: the strongest agree with the adjectives; 1: slightly agree, 0: Neutral)

1. How do you find the overall using process of this ATM?

3	2	1	0	1	2	3	
<hr/>							
Smooth	☐	☐	☐	☐	☐	☐	Not Smooth
<div>~ ~ ~</div>							

Functional Experience

(3: the strongest agree with the adjectives; 1: slightly agree, 0: Neutral)

1. Are the inputs (card reader, pin pad) of this ATM are easily identified?

3	2	1	0	1	2	3	
<hr/>							
Easy	☐	☐	☐	☐	☐	☐	Difficult
<div>~ ~ ~</div>							

Emotional Experience

(3: the strongest agree with the adjectives; 1: slightly agree, 0: Neutral)

6. Could you please express your emotional usage experience towards the design of this ATM according to the following categories?

3	2	1	0	1	2	3	
<hr/>							
Satisfied	☐	☐	☐	☐	☐	☐	Unsatisfied
<div>~ ~ ~</div>							

Figure 5-10. Sample questions for each part in the first section of the questionnaire

After participants had finished the three design evaluations, the study moved into the third stage. Here an interview was carried out with the second section of questionnaire used to investigate the relationship between user experience and contextual factors. During the interview, participants chose the ATM design concept they considered had fit best into the customized scenario

whilst giving reasons for their choice. (*Key question: Which of the three ATM designs fits the location of your customized scenario? Why?*). The participants also provided suggestions on possible usage scenarios for each ATM design concept. (*Key question: For each of the ATM design, can you describe a scenario or a location that it may fit into it?*) In addition, with the use of a 7-point scale, the ability of each participant to imagine scenarios was examined. Other questions related to usage scenarios were included, such as ‘*how often does this scenario happen in your real life?*’ and ‘*are there any other scenarios?*’. The participants’ subjective thoughts regarding the influence of usage scenarios on user experience were then consulted. (*Key questions: Do you think different scenarios will affect your ATM user experience? If yes, can you give some examples? Which contextual factors affect your user experience the most? Please describe how and why.*)

Accordingly, the interviewer then proceeded to ask the participant to compare the user experience under two different scenarios. For example, the participant may compare and contrast two situations: between having a companion and being alone; or between being in a queue of many people and not having to queue; or under different usage times or locations.

After the interview, participants completed the second section of the questionnaire on the associations among scenarios, contextual factors and user experience. Respondents ranked the degree of their agreement with various statements using a 7-point scale. Some examples of these statements are shown in Figure 5-11.

1. I think that different (ATM using) scenarios (different location/time of day, etc.) will affect my overall ATM using experience significantly.

3 2 1 0 1 2 3

Strongly agree ☐ ☐ ☐ ☐ ☐ ☐ ☐ Strongly disagree

2. I think that different scenarios will affect my functional experience significantly.

3 2 1 0 1 2 3

Strongly agree ☐ ☐ ☐ ☐ ☐ ☐ ☐ Strongly disagree

~ ~ ~

1. I think that the location of the ATM affects my ATM using experience the most.

3 2 1 0 1 2 3

Strongly agree ☐ ☐ ☐ ☐ ☐ ☐ ☐ Strongly disagree

2. I think that time of day affect my ATM using experience the most.

3 2 1 0 1 2 3

Strongly agree ☐ ☐ ☐ ☐ ☐ ☐ ☐ Strongly disagree

~ ~ ~

Figure 5-11. Sample questions for the second section of the questionnaire

5.3 Result analysis and discussion

The results of the case study are reported and discussed in this section. Each stage of the experiment collected both quantitative and qualitative data. The qualitative data was obtained using the Think Aloud Protocol (TAP) in the first and second stages, and through the use of interviews in the third stage. The quantitative data was gathered from survey questionnaires using a 7-point scale. From these data, the following sections discuss four main issues, namely:

- Individual differences in users' ideal usage contexts;
- Ability to imagine a co-built usage scenario;
- Impact of scenarios on user experience; and
- User evaluation on the ATM designs and their matching scenarios.

5.3.1 Individual differences in users' ideal usage contexts

Table 5-6. The UCF in the ATM case study (analysis stage)

Project Name: <u>ATM design</u>												
Part D. Used for <u>analysis stage</u> : record during user participation												
Stakeholders: Design researchers, Designers												
#	Users' Background Info.				Multiple Contextual Factors							Notes
	True User Record $U_{(ID)}$				Chosen Context Settings $UC_{(ID)}$							
	Gender	Age	Career	Income	Time level 1	Event level 1	Event level 2	Time level 2	Location	Companion	External factors	Scenario code
1	1	20~30	Student	0-2000	2	2	14	2	5	1	3	22/14/2513
2	2	20~30	Student	0-	1	1	1	2	9	1	1	1112911
//	//	//	//	//	//	//	//	//	//	//	//	//
34	1	20~30	Student	0-	1	1	1	1	9	1	2	1111912
	Where 1= male, 2= female				Where 1= weekday, 2= weekend	Where 1= indoor activities, 2= outdoor activities	Where 1= on the way to school, 2= on the way to office, 3= on the way home, 4= school hours, 5= office hours, 6= exercise, 7= shopping, 8= movie, 9= lunch, 10= dinner, 11= tea break, 12= project, 13= indoor eating out, 14= outdoor eating out, 15= indoor sport activity, 16= outdoor sport activity, 17= visiting friends, 18= religious activity, 19= other indoors, 20= park & garden, 21= picnic, 22= kite, 23= beach, 24= BBQ.	Where 1= morning, 2= noon, 3= afternoon, 4= evening, 5= night	Where 1= HDB, 2= supermarket, 3= hawker & food centre, 4= bank branch, 5= shopping centre, 6= convenience store, 7= MRT station, 8= bus interchange, 9= campus, 10= office & industrial building, 11= park & garden, 12= beach.	Where 1= alone, 2= with friends, 3= with family	Where 1= no people in queue, 2= 1~3 people in queue, 3= 4~6 people in queue, 4= more than 7 people in queue	

The results from the first stage of the experiment can help to verify whether different participants have different preferences in ATM usage contexts. With the aid of UCF, designers are able to view the records of diverse contextual factors or check the scenario codes to examine the co-built results (as shown in Table 5-6). From the 34 participants, a total of 31 different usage scenarios were generated. This result shows that even with similar backgrounds such as education and age, different participants hold different preferences on ATM usage contexts in real life.

Also gathered at the first stage were data on the various contextual factors. These are organized into pie charts to facilitate designers' understanding of the relationships between certain usage habits and usage contexts. Figure 5-12 presents participants' choices on the various contextual factors. Such information, along with the results from the questionnaire and interview, can help designers gain insight into not only users' lives, but also their thoughts and feelings. For example, during the interviews, some female participants said they felt embarrassed having their friends wait, so they preferred to use ATMs alone. Some participants said that they preferred to use on-campus ATMs since they felt a greater sense of security compared to using those that are off-campus, especially at MRT stations. As such, it appears that not only users' lifestyles but also their cognitive and affective experiences can affect their usage behaviour -- from the very beginning in the choice of a usage context (where, when and with whom to use an ATM). It is thus reasonable for designers to start from the contextual level rather than at user-product interactions.

Figure 5-12. The pie charts of the chosen contextual factors

5.3.2 Ability to imagine a co-built usage scenario

The participants' ability to imagine their co-built usage scenarios is important as it may affect the ensuing user experience and evaluation based on these scenarios. At the end of the first stage of the experiment, that is, right after the co-built usage scenario had been generated, the participants were asked how well he/she could imagine the scenario. The results are shown in Figure 5-13. A total of 82% (21%+29%+32%) of the participants responded that they were able to imagine the scenarios. However, there were two participants who stated that they did not have a most frequent ATM usage context, and thus they could not imagine the scenarios.

Figure 5-13. The pie chart of the participants' ability to imagine the scenarios

At the second stage, designers can observe how the participants were immersed in the situation, such as when they experience the ATM designs, with further evidence obtained from the TAP. For example, some participants were able to move easily from scenario co-building to user experience. They may thus be able to describe the scenario quite vividly before experiencing the ATM. Two examples are provided as follows.

“So I am walking towards the ATM... there was nobody in front of me, so I approached the ATM with my ATM card...”

“Now I need to withdraw \$50 dollars, I look for the banks that accept my card ... that I am drawing from. Then, once I find the ATM, I see there are people in front of me, and I join the queue. So waiting for...and he just left, so I go in front see whether the screen says that ready to withdraw cash or not...”

5.3.3 Impact of scenarios on user experience

The previous sections have suggested that there are individual differences in users' ideal ATM usage scenarios, and most participants can imagine their own co-built scenarios to experience an ATM. Nevertheless, one issue that should be

further examined is the necessity of providing such customized usage scenarios during a user involvement study. The exploration and understanding of how usage scenarios and contextual settings may affect user experience can assist decision-making on whether and how to adopt the SCS. Therefore, the impact of scenarios on user experience is discussed in greater detail in this section as follows.

5.3.3.1 Results from ANOVA

The quantitative results collected from the first section of the questionnaire (obtained users' overall, functional and emotional experiences toward the three ATM designs) were evaluated by analysis of variance (ANOVA). ANOVA is able to determine whether a factor has a significant effect on the response. In this experiment, a one-way between subjects ANOVA was conducted to compare the effect of scenarios on users' evaluation on the overall experience (A1 & A2), functional experience (B1 ~ B4) and emotional experience (C1 ~ C7). By setting $\alpha = 0.05$, the operational rules are as follows: If $p < 0.05$, the factor has an effect on the response. If $0.05 < p < 0.1$, the factor may have an effect on the response. If $p > 0.05$, the factor has no effect on the response.

The results of all the three parts have been summarized in Table 5-7. For part A – the overall experience, there was a significant effect of scenarios on A1 (smoothness) & A2 (ease) criteria remembered at the $p < 0.05$ level for the 31 conditions (for A1: [$F(30,62) = 4.843, p = 7.93997E-08$] ; for A2: [$F(30,62) = 4.479, p = 3.09194E-07$]).

For part B – the functional experience, there was a significant effect of scenarios on B3 (convenience of using the layout) criteria remembered at the $p < 0.05$ level for the 31 conditions [$F(30,62) = 2.376, p = 0.002$].

For part C – the emotional experience, there was a significant effect of scenarios on C1 (satisfied), C2 (pleasure), C3(comfortable), C4 (confident), and C5 (calm) criteria remembered at the $p < 0.05$ level for the 31 conditions (for C1: $[F(30,62) = 2.975, p = 0.000144]$; for C2: $[F(30,62) = 3.553, p = 9.090207E-06]$; for C3: $[F(30,62) = 2.433, p = 0.002]$; for C4: $[F(30,62) = 2.936, p = 0.00017098]$; for C5: $[F(30,62) = 2.132, p = 0.006]$).

Table 5-7. The results of the ANOVA analysis

Section 1						
Part 1		Part 2		Part 3		
A.		B.		C.		
				C1. $p = 0.000144$	C2. $p = 9.090207E-06$	
				$F(30,62) = 2.975$	$F(30,62) = 3.553$	
A1. $p = 7.93997E-08$	A2. $p = 3.09194E-07$	B1. $p = 0.862$	B2. $p = 0.734$	C3. $p = 0.002$	C4. $p = 0.00017098$	
$F(30,62) = 4.843$	$F(30,62) = 4.479$	$F(30,62) = 0.695$	$F(30,62) = 0.809$	$F(30,62) = 2.433$	$F(30,62) = 2.936$	
		B3. $p = 0.002$	B4. $p = 0.117$	C5. $p = 0.006$	C6. $p = 0.060$	
		$F(30,62) = 2.376$	$F(30,62) = 1.431$	$F(30,62) = 2.132$	$F(30,62) = 1.6$	
				C7. $p = 0.501$		
				$F(30,62) = 0.988$		
Average: $p \approx 0$		Average: $p = 0.429$		Average: $p = 0.081$		

*The definitions of A1 to C7 are shown in Table 5-5.

*The definitions of A1 to C7 are shown in Table 5-5.

5.3.3.2 Results from the self-report questionnaire

The questionnaire applied at the third stage of the experiment sought to examine participants' attitudes toward the scenarios and contextual factors and how these may affect their ATM experience. The results suggested that most participants were of the view the scenarios influenced their experience in four aspects: overall experience, functional experience, emotional experience and the willingness to queue, as shown in Figure 5-14. This is consistent with

previous findings by ANOVA which suggested that scenarios mainly influenced the users' overall and emotional experiences.

Figure 5-14. Participants' attitudes regarding the effect of scenarios on four aspects of user experience

Aside from the general scenarios, the participants' attitudes toward each contextual factor and how that may affect their experience were examined in part E of the questionnaire. As the results in Figure 5-15 reveal, the factor 'number of people in queue' appeared to have the most effect on the participants' user experience. For the contextual factors 'location' and 'time of

day', majority of participants indicated they only 'slightly agreed' that these would have a significant effect on their experience.

Figure 5-15. Participants' attitudes regarding the effect of diverse contextual factors on user experience

5.3.3.3 Results from self-reported interviews

The above results from the interviews provide a general view of how scenarios and contextual factors can affect certain aspects of user experience. Additionally, further examination of the results may enable designers to consider how usage contexts affect user experience. Take ‘location’ which can be linked to people’s backgrounds and which may influence their levels of security feeling and awareness. For example, the participants noted that the people mix at public areas, such as MRT stations, tend to be very diverse, and thus they consider the campus where most people are either students or teachers to be a safer area. Similarly, the participants were concerned about the use of sound in warning messages, particularly in crowded places, as that would attract attention. Conversely, in quieter and less crowded places, the use of sound that could alert users of a person approaching was viewed as a positive feature for an ATM. This indicates that the auditory feedback should be carefully handled to match the usage contexts. Otherwise, embarrassing or negative experience may occur.

Having to join the queue to use the ATM – the most commonly mentioned contextual factor during the interviews – also affected the emotions and behaviours of some participants. For example, when they saw a long queue at the ATM, they felt frustrated and some even walked away to look for another machine. Participants’ behaviour while waiting at the queue would also be affected by the ‘companionship’ factor. When queuing alone, they would use their mobile phone and would sometimes get impatient if the wait got too long. But when they were queuing with friends, they could chat and thus feel the waiting time passed more quickly. Such information is valuable as it may help

designers develop greater empathy for users and in turn produce more user-centred and consumer-oriented designs.

5.3.4 User evaluation on the ATM designs and their matching scenarios

In addition to the issues discussed previously, the user evaluation on the ATM designs are organized here and subsequently compared using the Pugh Matrix. After that, the ATM designs and their matching scenarios are examined.

The results from the first section of the questionnaire are first recoded. Originally, a 7-point scale, i.e. ‘3, 2, 1, 0, 1, 2, 3’, as shown in Figure 5-10 was adopted for participants to answer the questions. The scores are then recoded to ‘1, 2, 3, 4, 5, 6, 7’ for data analysis. In this manner, ‘1’ represents the best and ‘7’ means the worst. As an example, for criterion A1 – smoothness, ‘1’ represents ‘smooth’ while ‘7’ represents ‘not smooth’. The average score of the section one of questionnaire are then organized into Table 5-8.

Table 5-8. Results from the section 1 of the questionnaire

Criteria Code		A1	A2	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6	C7
		Average Score												
ATM Design Concept	Guard	2.38	2.32	2.38	1.53	2.38	2.44	2.65	2.74	2.71	2.62	2.53	2.53	2.26
	Desk	2.38	2.18	1.65	1.71	2.03	2.12	2.82	2.85	3.06	2.79	2.71	4.53	4.53
	Barrel	2.88	2.97	2.35	2.06	3.71	3.03	3.71	3.59	4.26	3.85	3.68	4.38	4.53

*The definitions of A1 to C7 are shown in Table 5-5.

Subsequently, the Pugh Matrix is employed to better compare the three ATM designs. The ‘Desk’ design is selected as the ‘baseline’ and is scored as ‘0’ against all of the criteria. The other two design concepts are then compared against the ‘Desk’ for each of the criteria. If a design concept is

- better than the baseline for a criterion, a “+1” is scored;
- the same as the baseline for a criterion, a “0” is scored; and

- worse than the baseline for a criterion, a “-1” is scored.

The results are then organized into Table 5-9. Overall, the first design ‘Guard’ obtains the highest score, especially on the emotional experience aspect. The design ‘Desk’ has higher score on the functional experience aspect while the ‘Barrel’ ranked the third on all aspects.

Table 5-9. The Pugh Matrix of the ATM designs

Criteria	ATM Design Concepts		
	Guard	Desk	Barrel
Part 1 : Overall Experience (A. Overall operation process of cash withdrawal)			
A1. Smoothness	0	0	-1
A2. Ease	-1	0	-1
Part 2 : Functional Experience (B. Usability of the design concepts)			
B1. Ease of identifying the inputs (<i>card reader, pin pad</i>)	-1	0	-1
B2. Ease of identifying the outputs (<i>money window</i>)	+1	0	-1
B3. Convenience of using the layout	-1	0	-1
B4. Effects of the pin pad arrangement	-1	0	-1
Part 3 : Emotional Experience (C. Evaluation of seven emotions)			
C1. Satisfied	+1	0	-1
C2. Pleasure	+1	0	-1
C3. Comfortable	+1	0	-1
C4. Confident	+1	0	-1
C5. Calm	+1	0	-1
C6. Secure	+1	0	+1
C7. Privacy	+1	0	0
Total +1	+8	0	+1
Total -1	-4	0	-11
Total Score	+4	0	-10

As discussed in Section 5.3.1 and Section 5.3.3, there are individual differences in users' ideal usage contexts and the contexts can have influence on different aspects of user experience. The research thus suggests designers not only examine user evaluation on the ATM designs but also examine how users relate the three ATM designs with the scenarios.

During the interviews, participants were first asked to select the design concept from among three that would best fit into their co-built scenarios. The participants with scenarios located in crowded areas, such as a supermarket or an MRT station, tended to select the 'Guard', which owns stronger protective and security features. By contrast, the 'Barrel' was more popular with participants whose usage scenarios were on campus, their main reason being that an ATM on campus should have an innovative, special and unique design.

Next, participants were asked to select the most suitable location or scene for each design concept. For the 'Guard', the participants generally stated that it was suitable to be placed anywhere, especially outdoors, and in residential areas. As it had a traditional yet modern appearance, it was easy for anyone to recognise it as an ATM machine. With its security and shelter features, it also provided privacy to users and thus it could be used in any location, both high and low human traffic areas, such as shopping centres, MRT stations, and parks. As for the 'Desk', 12 participants suggested that it to be placed at bank branches to address its lack of security features. Moreover, given its relative small size, it was better suited for indoor spaces. The 'Barrel' had a unique and special appearance which led 17 participants to suggest it could be placed near a beach or park due to its curvy design. Their view was that recreational places suited its fun and aesthetic design. Some participants also suggested that the

design's platform feature suit other locations such as supermarkets, markets, and shopping centres where people would be carrying their purchases in their hands.

This kind of the information and knowledge gathered can help designers and project managers as well as other stakeholders (e.g., the banks) better plan their marketing strategies and create successful designs that can fit the lives of people.

5.4 Conclusion

The ATM case study illustrated a user involvement study using the proposed SCS and UCF from preparation to execution. During the results and discussion stage, a number of issues regarding the usage scenarios and user experience were examined. Results from the case study suggested the presence of individual differences in participants' ideal usage scenarios for ATMs. Moreover, most participants were able to imagine their own co-built scenarios, and then to experience and evaluate three ATM design concepts. In addition, the results showed that usage scenarios and contextual factors can have an impact on users' ATM experiences and evaluations to a certain degree. Therefore, issues related to individual differences and diverse contextual factors should not be neglected in the discussion on user experience. One possible solution is to provide more customized scenarios that facilitate user involvement studies and to start from the contextual level, as this case study has illustrated.

Chapter 6 Conclusions

In the realm of PDD and NPD, consumers and users are always the key focus for developing successful products. Investigating and understanding the intricacies of user experience have become important priorities. For designers, the ability to create a more user-centric and consumer-oriented user experience is highly imperative.

This study contributes to ongoing research through its exploration of practical approaches that aid designers in the gathering of in-depth and comprehensive experiential knowledge on diverse aspects of the user experience. It attempts to bridge the research gaps and to overcome some of the limitations of conventional methods. One limitation is that the inherent characteristics of user experience, i.e. complex, subjective and dynamic, have yet to be well addressed. Hence, the research aims to address this limitation by exploring possible solutions that could strengthen the user involvement studies.

The research comprises a series of approaches: an integrated design strategy; a model to represent the user experience process; a systematic approach to guide PDD in applying the strategy; a practical guide and a flexible tool conceived for the ability to create more customized usage scenarios; and two case studies conducted to examine and illustrate the feasibility of the proposed approaches.

The summary of the research outcomes and contributions are presented in Section 6.1, while the limitations of the research as well as the future work possibilities are presented in Section 6.2.

6.1 Summary and contributions

An integrated design strategy

Bringing together current design strategies, namely ‘designing for experience’, ‘designing for emotions’, ‘designing for multi-senses’ and ‘designing from a contextual level’, this research proposed an integrated concept – ‘context-based multi-sensory experience exploration and design’ and its corresponding design strategy ‘designing for multi-sensory experience from a contextual level’. Accordingly, a series of approaches was proposed and introduced in Chapter 3. To demonstrate the approaches and to explore user experience, two case studies were conducted and detailed in Chapter 4 and Chapter 5. The results showed the proposed strategy to be a promising approach that could help designers examine, explore, and investigate user experience in a dedicated and robust manner that strengthens the experience design.

A model to depict the iterative user experience process – the UXC

This study proposed a prototype model, i.e. the User Experience Cycle (UXC), to represent and depict the iterative user experience process. As introduced in Section 3.1, the UXC used five stages to describe how a user encounters, then experiences, and then evaluates a product in a comprehensive and thorough manner. First and foremost, the UXC addressed the inherent characteristics of user experience, without moving directly into any product considerations. It discussed the issues arising from multiple contextual factors; diverse individual differences at different experiential stages; the rich cognitive, affective, and multi-sensory experience; and finally the experiential knowledge

and feedback that served to help design teams create more consumer-focused products.

In order to better describe the proposed approach, the UXC sought to mathematically represent the user experience, and its associated factors and relationships, as well as provide definitions for important key concepts. In doing so, it may facilitate communication between stakeholders from diverse backgrounds (e.g., designers, researchers, engineers, and project managers etc.).

A systematic approach to guide PDD – the CMSES

As introduced in Section 3.2 and based on the proposed strategy and UXC, a systematic approach was established, viz. the Context-based Multi-Sensory Experience System (CMSES), to guide the PDD process from user-involvement studies to design conceptualization in a user-centric, consumer-oriented, and experience-focused manner. The central concept of the CMSES is the investigation of the user experience under a specific and more customized usage context with sensory experience as the key starting point and premise, while handling multiple aspects of user experience. In short, the CMSES addressed the inherently complex, subjective, and dynamic characteristics of user experience, while conducting user involvement studies aimed at gaining experiential knowledge, which is considered to be more reliable and closer to a user's real situation.

A guide to inviting users to contribute to the usage contexts co-building – the SCS

As introduced in Section 3.3, this study revisited existing scenario techniques and improved them by tackling individual differences in personal

ideal usage contexts during user involvement studies. The CMSES incorporated a guide for designers and users to co-build more customized usage contexts. In this regard, the Scenario Co-build Strategy (SCS) was established such that users were able to experience and evaluate a product in scenarios perceived as being 'closer to life'. Yet, by allowing users to develop feelings of ownership, as they were encouraged to treat the product like their own property, there was a higher tendency for users to become 'emotionally attached' and thus be willing to offer more information and feedback (Beggan, 1992; Rijn & Stappers, 2008). Consequently, the experiences and evaluations acquired were assessed to be more valuable, reliable, and closer to the truth. By involving the user, the process was enhanced, becoming more interesting, relaxing, and creative so that users and designers alike became more inspired.

The use of co-built scenarios was introduced, characterised by the availability of different co-built structures and the application of different levels of freedom to co-build scenarios. General guidelines comprising five stages were proposed to guide designers from planning to the execution of the SCS. To co-build a scenario with a higher level of freedom, it was necessary for the initial SCS to first be constructed at a lower level of freedom and then gradually be built up to an SCS with a higher level of freedom. Therefore, it should be an incremental and iterative process.

The first case study proposed a scheme of SCS to facilitate 'context-based multi-sensory experience exploration and design'. The level of freedom was 'low-to-medium' such that participants were able to choose their preferred usage scenarios from a range of options without changing the contextual settings in the scenarios. The second case study applied another scheme of SCS

with a ‘medium’ level of freedom. Here, participants were permitted to make decisions on each contextual factor of the usage context, resulting in more customized usage scenarios being generated. In both case studies, participants were able to complete the co-build process, to experience the product, and to evaluate the product based on the co-built usage scenario. The results suggested the presence of significant individual differences in personal ideal usage contexts. In addition, multiple contextual factors had to be taken into account given their power to influence different aspects of user experience. Hence, designers should carefully consider individual differences and the influences of usage contexts in order to gain experiential knowledge that is of increased value and importance.

The proposed CMSES within an SCS was a lightweight and flexible approach that lent itself to being adjusted according to the project’s focus and needs. The more significant the context was for the product, the more robust the SCS needed to be constructed in combination with a higher level of freedom such that it was able to tackle a variety of scenarios. As illustrated in the two case studies, different schemes of SCS can effectively guide and assist designers in the in-depth exploration of user experience through user involvement studies.

A flexible and lightweight tool – the UCF

To assist designers in managing complex and diverse data, such as user background information and their ideal usage contexts, in a way that is designer- friendly, the general User–Context Form (UCF) was devised. As a flexible and lightweight tool that could be adjusted to suit different types of information and data (e.g., literal data, coded data, image, etc.), the UCF

identified the utilization stage and relevant stakeholders of the information. It can also be modified to suit the needs of stakeholders at different stages.

As demonstrated in the second case study (in Chapter 5), the UCF assisted in the information management of a user involvement study – from the preparation stage to the execution and analysis stages. For the case study, it was deployed in the organisation of data, including participants' background information, the multiple contextual factors and their corresponding parameters. For example, during the early phase of the preparation stage, designers would find it easy to represent all the factors and parameters in a straightforward literal manner. As the complexity of data rises, it can be further organized into a mathematical context in which the literal information is coded and presented as a mathematical formula. In doing so, software programmers could use the mathematical data, which is a more familiar and friendly method of representation, to create an interactive webpage. Subsequently, during the execution stage, while participants decided on their ideal usage contexts, the UCF could help record the user inputs in a convenient and manageable way – by simply filling in the corresponding code (which represents the chosen parameter) for each contextual factor. Finally, the data gathered in the UCF would be easily available to design researchers wishing to conduct further analysis. As the data is traceable, the relationship between usage contexts and user experience could be examined in detail. For example, it would be possible to observe and discuss how a certain contextual factor influenced users' attitudes and behaviours by examining the coded parameters, the scores of participants' evaluations, and the qualitative information collected during the execution stage.

The utilisation of quantitative data and qualitative information

As the two case studies demonstrated, the proposed design strategy and its corresponding approaches can facilitate user involvement studies as well as user experience exploration.

Since both quantitative and qualitative types of data were collected, it became possible to examine diverse aspects of user experience. The quantitative data (gathered from questionnaires) provided designers with evidence to check the existence of a phenomenon, confirm a statement, or observe a certain tendency. Quantitative data collected in this manner has the potential to help designers: investigate the participants' ideal usage contextual settings, analyse the trend of general user evaluations on different aspects of the user experience, examine participants' attitudes toward sensory importance, compare user evaluations of different designs, check the significance of the influence of usage scenarios on user experience, and the participants' abilities to imagine scenarios. At the same time, the qualitative information (acquired from observations, TAP, and interviews) represents an abundance of direct and implicit knowledge available to be mined by designers. It could improve the use of quantitative data such as for ascertaining the cause and effect of a tendency and to explore and explain a phenomenon in greater detail. For instance, through the use of qualitative information, designers would be able to investigate multi-sensory experience by examining sensory experience from each individual sense as well as the interactions between different senses. Designers could also observe how the usage scenarios and contextual factors affect participants' attitudes and experiences. They could examine how participants relate the different designs with the scenarios, assess the extent to

which a participant was immersed into a usage scenario, and even build a mental model of a design concept in his/her mind. Furthermore, given the open-ended nature of the knowledge gathered, particularly as no answer options were offered, the prospects of new ideas, surprising discoveries, and unexpected problems could be collected.

In considering the inherent characteristics of an experience during the case studies, participants' ideal usage contexts were in effect being consulted before the user experience session. Both quantitative and qualitative information collected were coded and linked up with the participants' user background -- their user experience and evaluation -- together with the ideal usage scenario and contextual settings. Since the experiential knowledge gathered was of traceable quality, designers therefore were equipped to discuss and elaborate user experience from a contextual level. Given that the knowledge gained was context-based and thus closer to the users' real lives, it would be regarded as being more reliable and valuable. In addition, other areas could be examined as a result of the quality of information available. For example, patterns of information could be discerned, such as when participants displayed common behaviours or provided similar rationales. Comments that surface with increasing frequency could be detected, such as those relating to a particular contextual setting in the usage contexts. Designers could tap on the availability of data to observe and discuss the influence of a specific contextual factor on user experience. Moreover, knowledge offering valuable insight, such as individual differences in different aspects of user experience, including personal sensory habits and ideal usage contexts, could be acquired. By having an in-depth and more comprehensive understanding of user experience, the design of

consumer-focused and experience-oriented products can be considerably advanced. Separately, it would also facilitate marketing research, market segmentation, and marketing strategies planning. Overall, the improved knowledge would create a more conducive environment in which companies could identify new opportunities for product innovation.

6.2 Limitations, opportunities and future work

Several limitations and corresponding future work have been identified as follows:

1. The experiment was conducted in a laboratory condition where the usage scenarios were presented using Microsoft PPT slides projected on a screen. Although the majority of the participants had stated they could imagine the scenarios, the representation method could still be further improved to strengthen the quality of the experiment.
2. By utilizing virtual reality techniques, future studies would have the potential to construct more realistic usage scenarios, especially for design teams keen to understand or predict user experience with regards to products planned for the future.
3. In the case studies, a limited number of scenarios were experienced, although the fact remains that a single product could suit multiple usage contexts, especially for certain product types, such as 3C products. While design teams may wish to investigate user experience in more diverse scenarios, the tradeoff factors of experiment time and cost would have to be considered.

4. In the case studies, only one user group was invited to be the participants. However, if more user groups with various backgrounds had been engaged, it is likely that a more diverse range of ideal usage contexts would have been identified. In this manner, scenarios where users with different backgrounds and a variety of products could be tested. By engaging more user groups, the relationship between user groups and their preferred usage contexts could also be investigated and that would facilitate consumer-focused design as well as marketing strategy planning.
5. Only two product types, namely the biscuit container and ATM, were investigated in the case studies. Given that user experience tends to vary for different product types (Schifferstein, 2006) and usage contexts for different products can also differ markedly, by using the SCS, future studies would be able to involve more diverse product types. The SCS could also open new ways to explore interesting areas, such as identifying the product type which suits diverse usage contexts or which requires more customised usage scenarios; or determining the product type that generates a user experience that, to a greater extent, is influenced by usage contexts; or understanding the contextual factors that would affect user experience for most product types, etc.

Aside from the research possibilities uncovered by the limitations and shortcomings described above, the results of this research can be considered to be laying the groundwork and providing references for future studies. Additional directions for future work are listed below.

6. Overall, the realisation of a potpourri of approaches and tools being available to handle the complex, subjective, and dynamic nature of user experience, including the organisation, integration, and implementation of experiential knowledge, has made the case for further investigative studies to be carried out.
7. In conjunction with current design trends, one integrated design strategy has been identified, namely 'designing for multi-sensory experience from a contextual level'. A series of approaches have been proposed and illustrated accordingly. The value of extended theoretical development in the prototype CMSES within an SCS would be worth investigating, as that would contribute to strengthening the robustness of the proposed approaches. For example, the theoretical formulation could be further improved and formal modelling of experience or new design evaluation models that explore user experience with multiple decision criteria could then be developed.
8. Further empirical studies are required to demonstrate the proposed strategy and approaches and to broaden the application scope by involving more stakeholders. The latter would act to facilitate successful implementation of user-centric and consumer-oriented design in the realm of PDD.
9. Two proposed schemes of SCS can serve as references for future studies that seek to develop additional schemes for SCS. These new schemes could have different levels of freedom for co-building

usage scenarios and would facilitate new product development in order to gain a competitive edge.

10. Some designers look for greater customization and creative usage scenarios. To meet these requirements, schemes of SCS at higher levels of freedom can be constructed. Likewise, a more robust system and diverse methods for designers and users to co-build a scenario with can also be developed. Future studies can explore and apply more techniques to guide the co-building process, apart from the interactive PPT and webpage used in the case studies.
11. The research scope focused primarily on the early stage of PDD, i.e. the product conceptualization stage. As the case studies demonstrated, designers could investigate user experience and collect context-based experiential knowledge using the proposed approaches. Future studies could involve further investigation into how the design strategy and approaches contribute to the other stages of PDD.

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