# Chapter 24
# Consumer Goods

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**Abstract** Product design and development (PDD) has shifted its focus from addressing functional and technological issues to user-centric and consumer-oriented concerns in recent years. More specifically, the experiential aspect of design has taken a crucial role in creating more consumer-focused products. Often, customer research or user-involvement studies are conducted to explore 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 exploration in consumer goods design deserve more attention. These will be the focus of this chapter. In this regard, a prototype context-based multi-sensory experience system (CMSES) with a scenario co-build strategy (SCS) is proposed to facilitate user experience exploration in designing consumer goods. A three-stage case study is employed to illustrate the proposed prototype system. Potential of the proposed approach in the context of concurrent engineering (CE) and collaborative product development (CPD) is discussed.

**Keywords** Customer requirement management · Multisensory experience · Product design · User experience · User involvement

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## 24.1 Introduction

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 issues caused by the sequential development process, which is usually lack of communication between different functions of a company and requires long development times [1, 2]. 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 variety, lower costs, better performance, higher quality and more rapid advancement [3]. 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 [4]. The key concept of CE and CPD is the early consideration and involvement of all relevant elements of the product life cycle (PLC) [5]. Accordingly, cooperation between multidisciplinary teams is indispensable. It has become a must to simultaneously consider much more complex requirements from different stakeholders by these teams [6].

As an implementation of CE and CPD, this chapter deals with the issues concerning user experience exploration in consumer goods design. More specifically, a prototype context-based multi-sensory experience system (CMSES) with a scenario co-build strategy (SCS) is proposed to facilitate user experience exploration. To illustrate the CMSES, this chapter starts with introducing the current trend of PDD in Sect. 24.2. This is followed by a description of the proposed methodologies, i.e. the CMSES and SCS, in Sect. 24.3. Subsequently, a three-stage case study on a biscuit container design is used to demonstrate the CMSES and SCS in Sect. 24.4. After that, Sect. 24.5 gives a general discussion regarding the case study and highlights the potential of applying the 'context-based multi-sensory experience exploration and design'. The last section, Sect. 24.6, summarizes the main conclusions reached in this chapter.

## 24.2 Related Work

Owing to the paradigm shift of the PDD process in recent years, apart from addressing functional and technological issues, user-centric [7, 8] and consumer-oriented [9] concerns have proven themselves to be as equally, if not more, important in developing a successful product. As a result, fulfilment of customers' needs and wants has become inevitable. Therefore, it is important to treat users or customers as stakeholders and invite them to contribute their views in the 'fuzzy front-end' of product development. The early user/customer input, knowledge integration and decision making may have a crucial influence on the cost, time-to-market, and the success or failure of a product, especially in the context of new product development

(NPD) [10–12]. In this regard, companies often conduct user involvement studies to discover and identify the genuine voice of customers (VOC) [13].

Moreover, in order to create more consumer-focused and successful products for the emerging experience economy that emphasizes selling experience [14, 15], companies should further concentrate their endeavours on the experiential aspect rather than merely the material one [16–19]. In other words, the VOC should include explicit, tacit, tangible and intangible customer requirements and the effort should be extended to an experiential level. To realize this idea in NPD, researchers encourage product developers and designers to treat users as experts of their own experience, explore potential user experiences and design for experience [20–22]. By exploring knowledge regarding user experience before and during design conceptualization, a company can better plan for its marketing and design strategies at an early stage and can be more confident about the product and its experience created to gratify the users.

However, during user experience exploration, designers may face some difficulties due to the fact that user experience is inherently complex, subjective and dynamic [23]. The characteristics and corresponding aspects of user experience are organized as shown in Fig. 24.1. Some issues might rise readily if such inherent nature of experience has not been taken into careful considerations when exploring it. Three major aspects of issues are identified as follows.
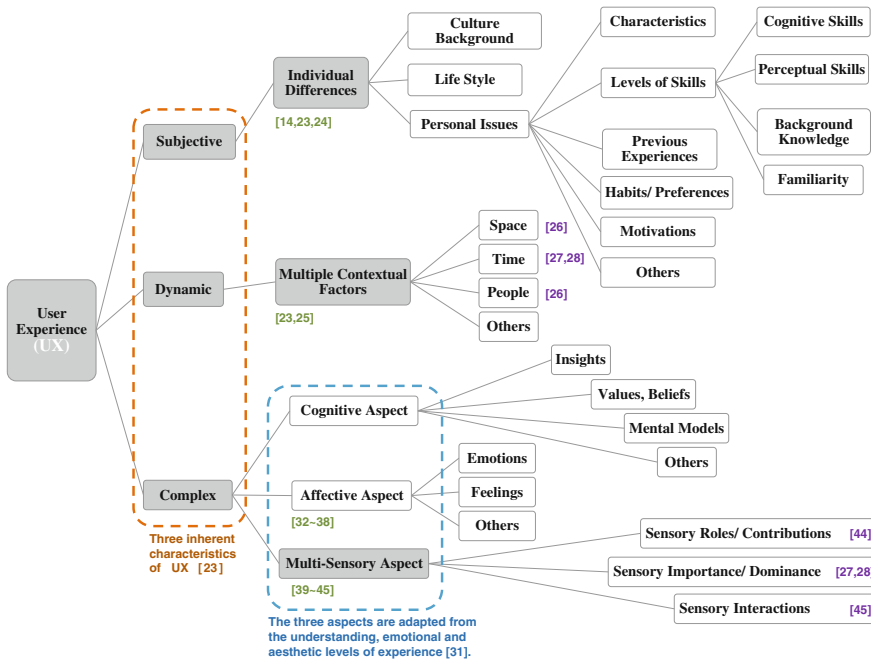


**Fig. 24.1** Different aspects of user experience

First (see Fig. 24.2), as an experience is inherently personal and exists only in the mind of an individual [14], it is important to treat users in a more personal manner [24]. 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.

Second (see Fig. 24.3), as a user's experience is dynamic and context-dependent [23, 25], it is inevitable to consider how multiple contextual factors may influence user experience. For example, 'companionship' is a powerful factor to have an impact on user experience [26]. It also requires attention that a user's multi-sensory experience may vary dynamically at different usage phases [27, 28]. Without tackling the contextual factors, user experience or evaluation may become ecologically invalid [29]. In addition, it is better to avoid treating a product as a starting



Fig. 24.2 User experience is subjective due to individual differences



Fig. 24.3 User experience is dynamic due to multiple contextual factors

point. Instead, designers are encouraged to redefine 'a product' as 'a context for experience' [30] and develop ideas from the 'contextual level', through the 'user-product interaction level', then to the 'product level' [22]. In doing so, designers can have a better exploration of user experience and prevent to become stuck by current designs especially for NPD.

Third (see Fig. 24.4), owing to its diverse and complex nature, user experience is difficult for designers to explore and discuss in a more comprehensive way. For example, it may cover cognitive, affective and sensory aspects as suggested by Hekkert [31] in his work on the three levels of experience: understanding, emotional and aesthetic. Recently, more and more researchers advocate the great value of emotional design [32, 33], affective design [34, 35] and Kansei (*a Japanese word for sensory*) engineering [36–38].

Furthermore, 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 [39–41]. In addition, it should not merely focus on visual aesthetics but should consider all of the senses [42]. Actually, user experience can be enriched to a certain extent if there are more sensory modalities involved [40] and more sensory memories activated [43]. Researchers have studied sensory experience from several facets such as roles of the senses [44], sensory importance [27, 28] and various kinds of interactions between senses [45].

Especially in the highly competitive era, companies are tackling much more complex design problems which no longer involve merely functional or cognitive aspect. It is quite a challenge for designers to deal with information or data of different format and characteristics, especially when experiential, intangible and



**Fig. 24.4** User experience is complex and comprises many different facets
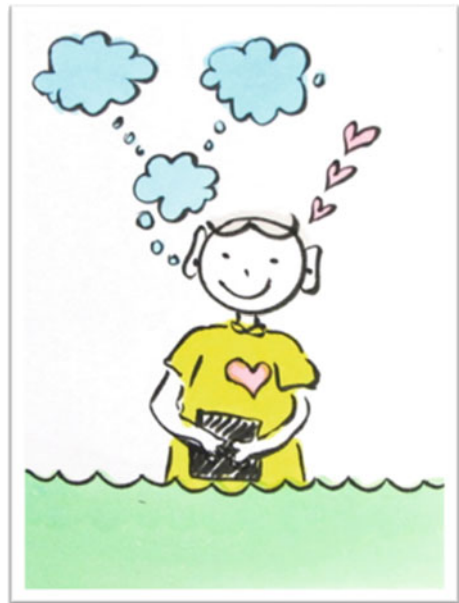
tacit elements are involved. Thus, the crucial key to create successful products lies in the integration of multiple factors from experiential, contextual and sensory aspects starting from the early stage of PDD [26].

In a nutshell, the main challenge is to concurrently deal with all these inherent characteristics of user experience during user involvement studies. Nevertheless, current studies seldom take these essential characteristics into more careful considerations during user-experience exploration. In addition, more practical studies, which demonstrate how designers can explore and discuss users' multi-sensory experience in a more in-depth and comprehensive manner, are still lacking. Based on these understandings, this study investigates the 'context-based multi-sensory experience exploration and design' to help designers get an in-depth understanding about user experience so as to facilitate experience design.

Although it is no easy task for a company to control or predict experience needs accurately [46], it is possible and justifiable to provide customers with their desired experience based on some prerequisites [46, 47] or exclude some potential negative experience. The deeper and more comprehensive the designers can understand user experience, the higher the possibility for them to create long-lasting pleasing products. Therefore, it is worthwhile to develop methods and tools to strengthen user-experience exploration.

## 24.3 Methodologies

To facilitate the effectiveness and efficiency of 'context-based multi-sensory experience exploration and design', a prototype CMSES with a SCS is proposed. The CMSES and SCS are demonstrated using a three-stage case study on a biscuit container design. Details are presented in the following sub-sections.

### 24.3.1 Context-Based Multi-sensory Experience System (CMSES)

A prototype CMSES is established to tackle the issues mentioned in the previous section. The system attempts 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, CMSES possesses the following characteristics.

1. User experience is explored under a specific usage context, which can prevent ecologically invalid results.
2. Individual differences are taken into consideration when tackling multiple contextual factors, such that the result can be more reliable and closer to a user's real situation.

3. As humans first perceive stimuli from their senses, it handles the multiple aspects of user experience starting from the sensory aspect then progressively bringing in more and more aspects.

Corresponding to the first and second characteristics, i.e., the subjective and dynamic nature of an experience, a SCS is applied. As shown in Fig. 24.5: Ⓐ: the SCS invites users in the decision making of scenario building, which was usually done by design teams and users can merely play a passive role. With the SCS, designers and users together may co-build a more customized scenario which can link up with one's real life more closely [26]; Ⓑ and Ⓒ: Customized scenarios can not only help to strengthen user-experience exploration at a later stage of user involvement studies but also provide valuable feedback of individual differences regarding usage context to the marketing department; Ⓓ: In this case, users may experience a product like they normally do in real life and may possess a feeling of ownership. By treating a product as one's own property, a user can become more 'emotionally attached' and be motivated to share more of his/her experience [48]. In doing so, the user-involvement process can be more relaxing, inspiring and creative; Ⓔ: Consequently, designers can explore more reliable and valuable feedback of user experience and evaluation. Corresponding to the third characteristic, i.e., the complex nature of an experience, designers can examine user experience in a more
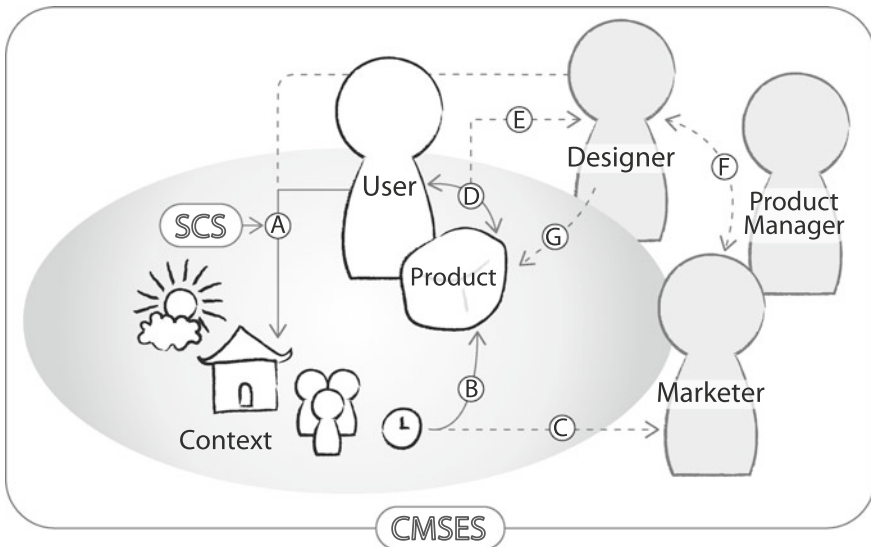


**Fig. 24.5** The context-based multi-sensory experience system (CMSES). *Note* Ⓐ: Scenario co-building (based on a user's real situation). Ⓑ: Customized scenario(s) (for the user to experience the product); Ⓒ: Feedback of individual differences regarding usage context; Ⓓ: Context-based user-product interaction (user experience); Ⓔ: Feedback of (multi-sensory) user experience and evaluation; Ⓕ: Design and marketing strategies concerning user experience; Ⓖ: Context-based multi-sensory experience design

detailed and comprehensive way by connecting 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; Ⓕ: Accordingly, a company can better plan for design and marketing strategies concerning user experience; Ⓖ: As a result, designers can conduct multi-sensory experience design from a contextual level in a more manageable manner so as to create a more long-lasting positive product experience.

### 24.3.2  Scenario Co-build Strategy (SCS)

Scenarios, describing the usage context, are frequently applied in a user involvement study for users to evaluate a system or product [49]. However, conventional scenarios are usually set up by design teams and, hence, fail to systematically take individual differences into more careful consideration. Thus, it may hardly reflect users' real life because of strong individual differences (e.g., different cultural background, life style, personal habits) in numerously varied societies worldwide [26]. The problem is crucial since user experience can be affected by multiple contextual factors defined in a scenario. In order to explore more useful and valuable user experience, the scenarios used in a user involvement study should fit into user's real life as much as possible [26]. In addition, users should not play a passive role during user participation. Instead, users should be treated as 'experts of their own experience' [22] and own the freedom to build their own experiences [17]. Based on such understandings, a SCS is established to address the issue by providing users with the opportunity and freedom to decide the scenario that is the most suitable for them [26]. The idea is for users and designers to co-build more customized scenarios (Fig. 24.6) so as to strengthen user experience exploration in user involvement studies. The co-built scenarios may have different structures and levels of freedom, depending on how much and how detailed users can contribute to the context settings of a scenario.
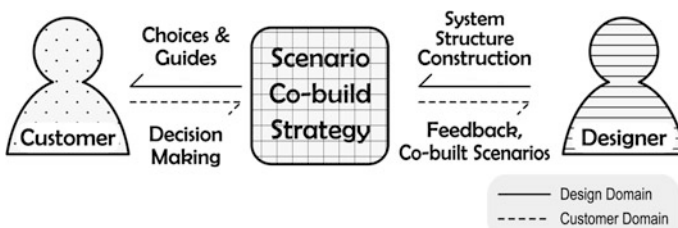


**Fig. 24.6**  The scenario co-build strategy (SCS); (adopted from Chen et al. [26])

## 24.4 Case Studies

To demonstrate the CMSES and SCS, a three-stage case study was conducted. At the first stage, users' multi-sensory experience and evaluation were explored and discussed. At the second stage, five biscuit container design concepts were generated based on the experiential knowledge gained. Subsequently, a survey was carried out to evaluate the concepts, and then a preferred concept is chosen and improved at the third stage.

### 24.4.1 The First Stage

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

#### 24.4.1.1 Methodology

The product chosen in the case study is 'Mary Biscuit' of the design brand 'Alessi' (see Fig. 24.7). The design features, e.g., the biscuit shaped lid with vanilla scented and special texture, make 'Mary Biscuit' stand out from other competitors. Five participants were invited to perform a pilot study and 33 participants (Mean age = 23.36 years, age range: 20–26 years; 15 female and 18 male) were invited to perform the formal experiment.

Based on the scheme of SCS proposed by Chen et al. [26] (see Fig. 24.8), this study investigates two main phases of user experience, namely the trial and usage phases. At the trial phase, the users purchase the product and interact with it for the first time. At the usage phase, the users get to know more about the product and have fresh experience with it.

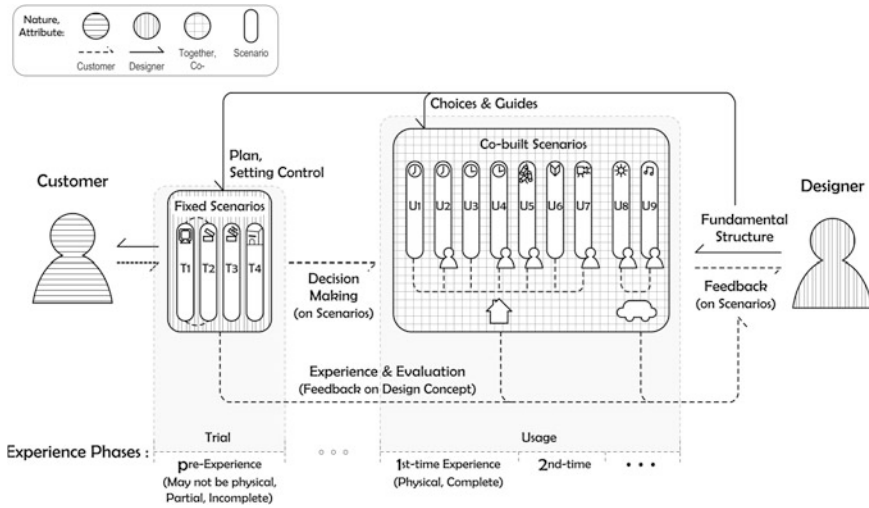**Fig. 24.7** 'Mary Biscuit' of the design brand 'Alessi'

**Fig. 24.8** One possible scheme of SCS; (adapted from Chen et al. [26])

More specifically, each participant experienced and evaluated 'Mary Biscuit' under both trial scenario(s) and usage scenario(s). At the beginning, trial scenario(s) were assigned to participants for them to experience 'Mary Biscuit' for the first time. Subsequently, based on the experiences and understanding about the product, participants can then choose preferred usage scenarios at the usage phase. The trial scenarios include three basic situations of the obtainment of the product while the nine usage scenarios cover both daily use and special events (see Table 24.1).

The experiment was conducted in a laboratory. There were two laptops to present scenarios and questionnaires respectively and two video cameras to record the process. The time was controlled within 45–60 min. Microsoft PowerPoint (PPT) slides were used to guide participants choosing preferred scenarios and representing the chosen ones. Scenarios are represented through descriptors (textual narratives), images (of the context) and videos (only for online webpage scenario) to help participants build a mental model of the usage occasions. Both qualitative methods (i.e., think-aloud protocol (TAP), observations and interviews) and quantitative questionnaires were used to collect different kinds of information and data.

### 24.4.1.2 Results and Discussions

To better represent the knowledge regarding users' multi-sensory experience, the qualitative and quantitative results were put together and the discussion was separated according to seven issues, A–G, as follows.

A. **Sensory importance**

To discuss the multi-sensory experience, sensory importance is first examined. Participants' attitudes toward the importance of each sense were solicited using

Table 24.1 Scenarios and participants record

| Phase (way to provide scenarios) | Code | Scenario | Note | No. of participants | Participant code |
|---|---|---|---|---|---|
| Trial (assigned) | T1 | Virtual shopping 1: online webpage | Buy, virtual | 11 | 4, 12, 20, 21, 22, 23, 26, 28, 29, 30, 31 |
| | T2 | Virtual shopping 2: receiving order | | | |
| | T3 | Receiving gifts at home | Granted, physical | 11 | 1, 2, 3, 5, 6, 7, 10, 15, 19, 24, 32 |
| | T4 | Physical shopping at store | Buy, physical | 11 | 8, 9, 11, 13, 14, 16, 17, 18, 25, 27, 33 |
| Usage (self-choosing) | U1 | Breakfast, alone | Indoor, daily use | 2 | 1, 7 |
| | U2 | Breakfast, with family | Indoor, daily use | 1 | 15 |
| | U3 | Afternoon tea, alone | Indoor, daily use | 1 | 11 |
| | U4 | Afternoon tea, with family | Indoor, daily use | 6 | 8, 22, 24, 28, 30, 31 |
| | U5 | Festive seasons, (e.g., Chinese new year), with companion | Indoor, special event | 11 | 3, 4, 5, 6, 10, 14, 18, 21, 25, 26, 32 |
| | U6 | Examinations, alone | Indoor, special event | 6 | 2, 9, 12, 19, 20, 29 |
| | U7 | Movie marathons, with companion | Indoor, special event | 3 | 13, 23, 27 |
| | U8 | Picnic, with Companion | Outdoor, special event | 9 | 10, 16, 17, 18, 24, 27, 28, 30, 33 |
| | U9 | Attending a party, with companion | Outdoor, special event | 1 | 12 |

questionnaires after each scenario experiencing. The overall results show that vision is the most important sense, followed by touch, olfaction and audition. Though for some scenarios the average scores seem to be higher, there is no significant difference.

In the afterward questionnaire, participants' attitudes towards what kinds of design features can affect their purchasing decisions were further solicited for those who experienced T1, T2 and T4 scenarios (in which the obtainment of the product is buying but not granted as a gift; there were totally 22 participants). The results suggest that most participants care about tactile experience (counted 19 times), followed by special features (which can relate to any sensory experience once it shows the uniqueness compared to others) (18 times), and the visual experience (17 times). Seven participants thought that olfactory experience is also a concern while no participant gave credit to auditory experience. It is known that there is usually a dominant sense during user-product interaction that can collect more information, have more influence, and attract more attention [39]. Yet, the sensory dominance or importance may be affected by product types [50], product characteristics [44] and the stages of usage [27, 28]. Although the study included both trial and usage phases that participants experienced 'Mary Biscuit' for at least two times, the experiences were still very fresh and belonged to early phases of product usage (e.g., the early stage of product experience [27] or the buying stage [28]). Usually at such phases, vision can have more influence and importance than other senses [27, 28]. Furthermore, under most situations vision can gather most information of a product in the shortest time compared to other senses [39, 44]. 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.

B. **Visual experience**

Vision, in this case, plays an important role in both cognitive and affective aspects of user experience. First, participants relied heavily on vision to form the first impression, explore the functions, examine and evaluate the product. Especially in the scenarios in which the main function of the product is unrevealed (as in T4 scenario participants find the product on the showcase along with other goods without being informed it is a cookie container), participants mainly inferred the product function from the overall form (as a container) and the biscuit shaped lid (as to store cookies). This result is in line with Alessi's design philosophy 'form follows function'. Second, the product's overall form can elicit many kinds of associations including 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 really treated 'Mary Biscuit' as a pillow to lay it near the head or a cushion to hug in the arms. Third, a lot of interactions were aroused by the biscuit shaped lid (along with other sensory design features: colour, texture, scent), e.g., "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, there's a biscuit, do you want to eat? (P10, Interview, U5)". Fourth, plenty positive emotions (e.g., happiness, surprise, funny, interesting and satisfaction) can be evoked by the pleasing form of the container as well as the biscuit shaped lid while some negative emotions (e.g., disappointment, worry and concern) can be evoked by the middle-line (i.e., a join line between the lower and upper parts as shown in Fig. 24.7) of the container. Yet this middle-line of the translucent container is related to not only the aesthetic aspect but also the functional aspect of the product such as durability; e.g., "makes me worry that the Mary will break easily (P26, Interview, T2)".

C. **Tactile experience**

It is found that the form of the product can further affect participants' tactile experience. For instance, the middle-line of the container may become a disturbance while touching the overall form, which consequently affects participants' feelings, e.g., "I don't like this [act: touch the middle-line]. I'd like it to be one piece (P28, Interview, T2)". Take the concave shape of the bottom as a positive example, many participants praised that the shape is friendly for hands to hold, e.g., "if I want to hold it by one hand to serve people, it's quite easy to hold (P6, Interview, U5)". There is also the case that through touching, participants can explore the more detailed form apart from merely viewing the product, especially when there are some special shapes or irregular contours, e.g., "you have to feel and touch the shape, you can't really visually see the shape, like the bottom, you can't see the specialty of it until you touch it (P15, TAP, T3)".

Besides the form, the special texture also matters a lot, because it can bring more 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. On the one hand, tactile experience can affect most participants' purchasing decision as the results shown above. On the other hand, participants would examine the product in a more detailed way through touching, thus, even minor matters can become a plus or minus point. For instance, the edge of the opening of the container can be an issue, 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)".

D. **Olfactory experience**

In terms of olfactory experience, participants showed great individual differences from various aspects. First, participants reported diverse individual sensory preference or habits toward the vanilla-scented lid. On the one hand, some participants held a quite positive attitude toward the scent and they may highlight this feature to their (imagined) companion, e.g., "I tell you what, this box is really special eh~ come smell smell smell (P5, TAP, U5)". On the other hand, some participants kept a negative attitude and 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 few participants who did not consider the scent as an issue. In fact, participants' personal preference is

closely linked with affective emotions. For participants who liked the smell, they tended to smell the lid for more than once and some positive emotions also came along, e.g., "like to go back and smell over, over, and over again (P23, TAP, T2)" and "because of the smell, very happy, since I bought the right thing (P4, TAP, T2)". Participants who did not like the smell would also behave greatly with strong emotions. Additionally, the emotions evoked by the scented lid (either positive or negative) are 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 [51]. As highlighted by Spence [51], the importance of olfaction is obvious and "the products of tomorrow will embrace the olfactory revolution (p. 3)." Indeed, 'Mary Biscuit', with such olfactory feature, is found to be able to bring users quite vivid emotions and differentiate itself from other containers. Furthermore, the sensory preference can further affect the way how participants treated the lid and their attitude with regard to the fading away of the scent after 1–1.5 year. Generally, those who adored the scent may choose not to wash the lid and may wish the scent could stay longer. Whereas those who dislike the scent claimed that they wish to wash the scent away and may like 'Mary Biscuit' more once the scent faded away.

Second, there is diverse individual difference in the interpretation of possible interactions between the vanilla-scented lid and the food stored inside. For example, a few participants looked on the bright side and imagined the taste of the cookies stored inside may become tastier. Yet some participants not only worried the food inside may be affected by the scent in a negative way but also were concerned about the artificial smell in a food container could be harmful to the body. As a result, the scent may affect participants' decision-making regarding what to contain. Some participants claimed that they would not use it to contain food, some would choose biscuit with wrappers so that the flavour (of biscuit) will not be affected, some may avoid strong scented food so that the scent (of the lid) will not be affected and some stated they would choose the biscuit that can match the flavour of scent.

Despite the fact that there are great individual differences in participants' sensory habits and preferences, the special olfactory feature does help 'Mary Biscuit' stand out from other competitors; not only because the scent can evoke plenty emotions and enrich one's affective experience but also because it can be an icebreaker to open a topic and enable many interactions among people. However, while designing this kind of special sensory features, designers should be careful about possible sensory interactions. As Schifferstein and Desmet [52] 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 colour scheme of 'Mary Biscuit' chosen is 'ice', in which the container is translucent and the lid has normal biscuit colour. It seems to be logical and coherent when the biscuit colour matches the vanilla scent. Nevertheless, other colour schemes of 'Mary

Biscuit' provided by Alessi also include white, orange, blue and green; yet there is only one flavour of smell—the vanilla scent. In the study, participants can observe the different colour schemes from the online shopping webpage (in T1), from the package while receiving as a gift (in T3) or by asking the clerk to show them (in T4). One participant originally said he preferred green colour. However, after he knew the scent is still vanilla flavour he changed his mind immediately. Furthermore, he commented the combination is "definitely a wrong design concept (P8, Interview, T4)". In addition, he gave some suggestions such as "not only depending on colour preference, but also smell preference we can choose (P8, Interview, T4)". Besides the sensory interactions, it is also worthwhile for designers to identify how the context may affect one's sensory preference. For example, one participant noted while experiencing the 'Examinations (U6)' scenario that "if I'm studying, I'd rather this [the lid] is coffee scented (P29, TAP, U6)".

Considering possible individual sensory preference, the afterward questionnaire solicited participants' preferences toward the flavour of the scent. The results show 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 have more careful consideration including possible sensory interactions as well as diverse individual sensory preference and habits.

E. **Auditory experience**

In discussing auditory experience, the product sound considered here is the sound produced while closing the lid, which is found closely related with the functional aspect—the tightness of lid. This can be an important issue especially for such product as a food container where 'air-tight' is one of the essential considerations. It is commonly believed by participants that if the lid can close tightly, there should be a clear clicking sound as a feedback while pressing down. Hence, when a light and soft sound replaced a clear clicking sound, many participants showed their concerns. As a result, some negative emotions (e.g., worry, concern, disappointment and unsafe) were evoked due to the problem. Similar to other senses, there are individual differences in personal sensory preference and the 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)". Besides, some participants found that since 'Mary Biscuit' is less noisy than other containers, it can fit into some special usage occasions well, 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)".

F. **Sensory design features and usage occasions**

Based on the results of the case study, it is suggested that sensory design features might be able to affect a product's suitable usage occasions. In this

sense, besides designing from a contextual level [22], it is further suggested that designers should always return to the contextual level after design conceptualization to check whether different sensory design features could help the product fit well to the targeted usage contexts or not.

G. **Individual sensory preference and designs in the market**

Among all the multi-sensory experiences, it seems there are more individual differences in the olfactory and auditory experiences. 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., view an event from different points of view) and personal sensory sensitivity (e.g., initial feelings of perceptions or physical sensitivity toward a stimulus). Nevertheless, most products in the market today still primarily emphasize the visual aesthetic [28], some may further secondarily strengthen the tactile gratification, but few would consider special olfactory or auditory experience unless the product is directly or strongly related to smell (e.g., perfume and deodorant) or sound (e.g., musical instruments and washing machine). In other words, while purchasing a product, usually a customer can have plenty of choices of various forms, sizes, colours, materials and even textures but may have little or no choice of special olfactory or auditory features (except certain types of product, e.g., perfume). Based on the example of olfactory experience illustrated, participants had diverse needs and wants regarding the olfactory experience yet there was no opportunity for them to choose their preferred sensory features, e.g., the intensity or flavour of the scented lid. As a result, not only some segments of customers cannot be satisfied but also the company may lose some segments that tend to have stronger personal sensory preference or sensory habits.

Hence, it can be a good opportunity for a company to design for all senses (i.e., multi-sensory design) in a more considerate way contemplating various individual differences to satisfy more segments and differentiate a product from many competitors. For example, the concept of 'mass customization' can be applied to increase sensory design features (and sensory experiences) variety while controlling manufacturing cost in order to create more customized and personalized product that can fit individual customer's condition better.

## 24.4.2 The Second Stage

The main purpose of the second stage of the case study is to carry out concept generation for the biscuit container design. Based on the experiential knowledge gained from the first stage, 15 design concepts were created for the young segment. These concepts were further categorised into five groups and, subsequently, a final design concept was chosen and revised from each group. Thus, five biscuit

container design concepts in total 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.

The first design, 'Mushy' (see Fig. 24.9), is a marshmallow-shaped biscuit container with matte surface. The internal surface of Mushy is in brown colour, which suggests the container is filled with chocolate and, hence, may increase users' appetite. There are two ants heading towards the overflow chocolate. The white colour external surface of the 'Mushy' causes this part to become the highlight of the design. The intention is to make users feel curious and make them investigate what is inside the 'Mushy'. The snap-fit lid is easy to open. Besides, there is sweet scent on the external surface of the lid. Users can choose the scent they desire while purchasing 'Mushy'. Available sweet scents include caramel, chocolate, vanilla and honey.

The second design, 'Passion' (see Fig. 24.10), is an orange-shaped biscuit container with matte surface. The matte surface is to suggest similarity of this biscuit container with real orange. This container comprises a tissue paper chamber and six compartments for users to contain and sort various cookies. The transparent biscuit container lid allows users to see 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 taken out easily by simply lifting it upward. Both biscuit container lid and tissue paper chamber lid are snap-fit. The tissue paper chamber lid is further customized with fruit scent.

The third design, 'Desire' (see Fig. 24.11), is a snap-fit container with chocolate shape and is made of brown matte plastics. There is a stickman, which is a tissue paper container, lain on the top of 'Desire'. The happy and bright smile on the stickman may cheer users with some positive emotions. Users can play with the stickman and have more interactions with their companion. The tissue paper



**Fig. 24.9** The first design: 'Mushy'

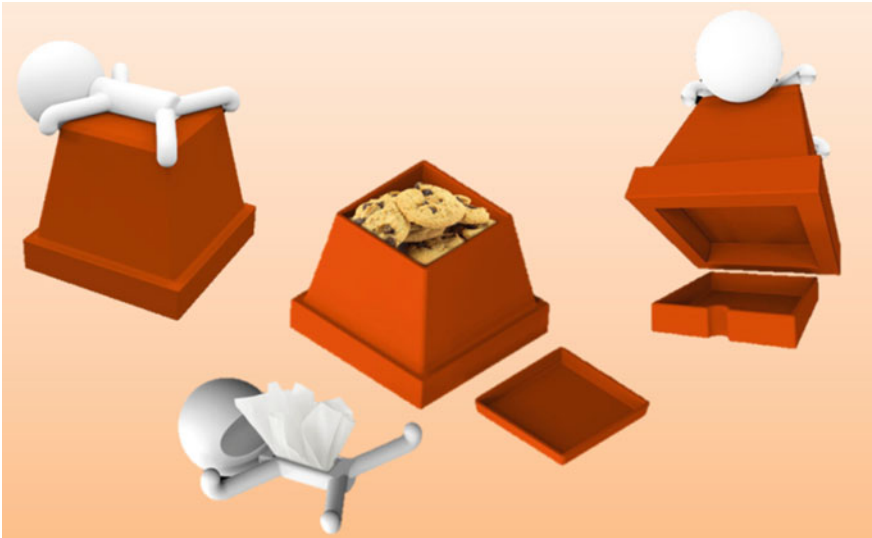**Fig. 24.10** The second design: 'Passion'



**Fig. 24.11** The third design: 'Desire'

container has two choices of scents, which are chocolate and milk. A temporary waste storage, hidden at the bottom of the container, is designed for users to throw their waste easily and conveniently.

The fourth design, 'Sharkie' (see Fig. 24.12), is a shark-shaped biscuit container with white colour and glossy surface. It is a screw lock container. There are some functions available. Users can estimate the level of cookies inside 'Sharkie' through the transparent eyes. 'Sharkie's mouth is a tissue paper holder. There is an inbuilt cutter in the fin for users to open food packaging. As shown in Fig. 24.12, users can slide the food packaging downward through the inbuilt cutter to create a small opening in the packaging. The cutter is built in the fin to ensure safety of users especially children. The slit is designed narrow enough to avoid children to put in their fingers. The fin comes with a variety of scents for users to choose, including fruits, sweet, mint, coffee, perfume, etc.

The fifth design, 'FreshMint' (see Fig. 24.13), 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 reminds them of tooth paste. This may further remind users to brush their teeth after eating.

In order to compare the design concepts generated with 'Mary Biscuit', the CAD model of it was also created (see Fig. 24.14). The representative sensory design features of the 6 biscuit containers were summarized as shown in Table 24.2.
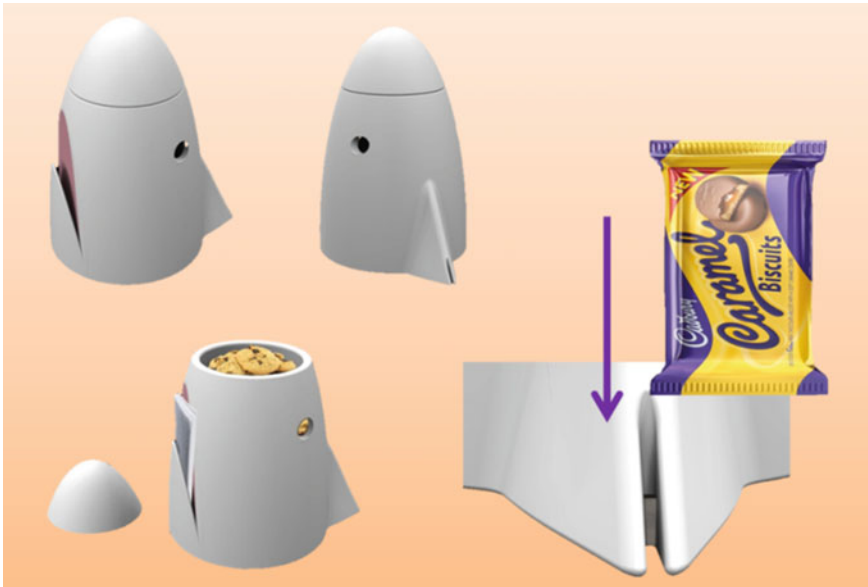


**Fig. 24.12** The fourth design: 'Sharkie'

**Fig. 24.13** The fifth design: 'FreshMint'
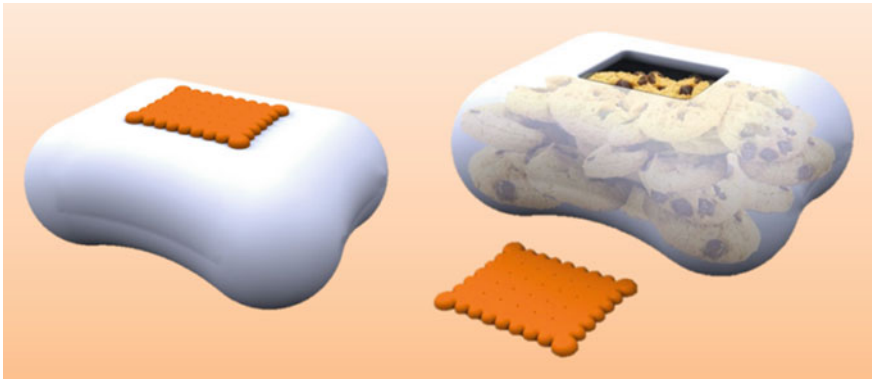


**Fig. 24.14** The CAD model of 'Mary Biscuit'

## 24.4.3 The Third Stage

### 24.4.3.1 Methodology

The main purpose of the third stage of the case study is to investigate the potential user experience and generate a more consumer-focused design. Therefore, a customer survey was conducted to evaluate the 6 design concepts, namely 'Mushy', 'Passion', 'Desire', 'Sharkie', 'FreshMint' and 'Mary Biscuit', and explore 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 and 16 male) were invited to accomplish the survey. They were recommended to complete

**Table 24.2** The main sensory design features

| Design |  Mushy |  Passion |  Desire |  Sharkie |  FreshMint |  Mary biscuit |
|---|---|---|---|---|---|---|
| Sensory design features | | | | | | |
| Visual | Marshmallow shape, matte surface, ants, overflow chocolate, brown colour internal surface, snap-fit lid | Orange shape, matte surface, tissue paper chamber, compartments, 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 |

the survey with their first thought answer. To avoid bias, no participants at the third stage were involved in the first stage of the case study.

The survey was presented using PPT slides. It consisted of two major parts, viz. individual evaluation and comparison evaluation. In individual evaluation, participants evaluated the design concepts one by one and they were told not to compare the six 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 six 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 24.2) and providing reasons
6. Extra comments and feedbacks.

During the 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.

### 24.4.3.2 Results and Discussions

As illustrated in the case study, sometimes designers have to conduct user or customer research while the design concepts are not yet 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 that complete [53] and users need to interact with the product through limited sensory modalities (mainly relying on visual experience). However, it is believed that the close interrelations and interactions among senses may help to compensate the absence of some stimuli to a certain extent (though it is impossible to fully compensate or replace). For example, the auditory information can be used to improve the visual or tactile perceptions [54–56]. Peck and Childers [57] used "written descriptions and visual depictions of products" to help people obtain tactile information. Thus, designers can still capture valuable potential user experience concerning different aspects of experience if enough information is provided to the users. As shown in Fig. 24.15, one advantage of PPT slides is its convenience and flexibility to better present the designs with images and textual descriptions.

The following discussion is divided according to seven issues, A–G.

**Fig. 24.15** Samples of PPT slides in the customer survey

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 that may affect their experience and purchasing decision. By checking with analysis of variance (ANOVA), it is found that there are no significant individual differences ($p$-value = 0.817605) between participants. However, there are significant differences on criteria ($p$-value = 7.19E−31). It is possible that 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**

After viewing and getting to know each design concept, participants were asked to evaluate the product and its potential experience with their first thought during the individual evaluation. Initial user experience is captured by mainly three aspects. First, participants' visual experience with product appearance was examined. As shown in the first part of Table 24.3, the design concept 'Desire' has the highest average ratings compared to the rest, followed by 'Sharkie', which is relatively close to 'Desire'.

**Table 24.3** The average ratings of user evaluation on the appearance, functional experience and emotional experience during the individual evaluation

|  | Mushy | Passion | Desire | Sharkie | Fresh Mint | Mary biscuit | *P*-value |
|---|---|---|---|---|---|---|---|
| *Appearance* | | | | | | | |
| Pleasant | 2.65 | 2.85 | **3.13** | *3.05* | 2.44 | 2.65 | 0.05089 |
| 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* | | | | | | | |
| 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 | 0.36022 |
| *Emotion* | | | | | | | |
| Happy | 2.45 | 2.52 | **2.71** | *2.66* | 2.26 | 2.35 | 0.4364 |
| Inviting | 2.46 | 2.44 | **2.83** | *2.65* | 2.23 | 2.16 | 0.0811 |
| Active | 2.22 | 2.24 | **2.63** | *2.52* | 2.22 | 2.01 | 0.1213 |
| 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 | 0.0730 |
| Comfort | 2.40 | 2.43 | **2.70** | *2.53* | 2.23 | 2.31 | 0.5124 |

*Note* The bold and italic values respectively represent the highest and second high average ratings.

Second, the average ratings of functional experience evaluation are shown in the second part of Table 24.3. Different design concepts have no significant effect on the criterion 'safe' but do have effect on the criteria 'practical' and 'durable'. Overall, 'Desire' and 'Sharkie' have the most practical function. 'Mushy', 'Sharkie' and 'Passion' are more durable amongst all the biscuit containers. Lastly, the safety of 'Desire' and 'Mushy' are slightly higher compared to the rest.

Third, emotional experience evaluation is shown in the last part of Table 24.3. The result indicates that different designs of biscuit containers have effects on the 'surprise' criterion and may have effects on the criteria '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 suggests obvious individual differences in personal olfactory habits. For those participants who do not appreciate scents as an attractive design feature chose 'no scent' for most of the designs. For those who enjoy olfactory experience tend to have their own preferred type of scent for different designs. In addition, visual design features tend to have an influence on participants' decision making on the scents. For example, for the design 'Desire', whose shape and colour are directly linked to food—chocolate, 14

participants chose the scent to be chocolate flavor. As for the design 'Fresh-Mint', whose shape and colour resemble tooth and toothpaste, 18 participants chose the scent to be mint. On the contrary, for the design 'Sharkie', whose shape is not really related to food, most participants chose it to be no scent.

D. **Design concepts and the suitable usage occasions**

During individual evaluation, participants chose their preferred usage occasions in which they would like to use the biscuit container. Corresponding to the first stage of the case study, the usage scenarios included both daily use occasions and special events occasions.

The accumulation of chosen times for each design concept and each usage scenario are shown in Table 24.4. 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 the trade-off in decision making. 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'. However, if a company tends to cover more possible usage occasions in order to attract more consumers, the design concepts 'Desire' and 'Sharkie' are more ideal as they are suitable for more usage occasions whether for daily use or special events. From a different point of view, if a company is

**Table 24.4** Sum of participants' decision making on the preferred usage occasions

| Biscuit container | | Mushy | Passion | Desire | Sharkie | Fresh mint | Mary biscuit |
|---|---|---|---|---|---|---|---|
| Daily use occasions | Breakfast **alone** | 10 | 7 | 11 | 11 | 13 | 12 |
| | Breakfast **with family** | 9 | 14 | 12 | 12 | 12 | 12 |
| | Afternoon tea **alone** | 14 | 9 | 14 | 14 | 16 | 15 |
| | Afternoon tea **with family** | 15 | 17 | 15 | 14 | 12 | 12 |
| Sum of daily use occasions | | 48 | 47 | 52 | 51 | 53 | 51 |
| Special events occasions | Festive seasons **with companion** | 17 | 26 | 15 | 15 | 7 | 11 |
| | Exam **alone** | 9 | 9 | 16 | 16 | 17 | 12 |
| | Movie marathon **with companion** | 11 | 5 | 13 | 12 | 10 | 10 |
| | Party **with companion** | 14 | 17 | 16 | 14 | 11 | 9 |
| | Outdoor activities (e.g., picnic) **with companion** | 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 |

going to launch 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 learn from this to know which design features can be in the spotlights and which may be unsuitable for some usage occasions. There is actually much more one can learn and benefit if considering such contextual factors during user experience exploration.

E. **The comparison evaluation**

During the comparison evaluation, participants compared all six design concepts mainly from three aspects. First, participants compared the concepts from a functional point of view. As shown in the first part of Table 24.5, 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 24.5. The result suggests that the designs of biscuit containers have effects on all emotional experience evaluations. Similar to the result from individual evaluation, 'Desire' and 'Sharkie' have the highest ratings for all aspects of emotional experience.

Third, participants' willingness to purchase the biscuit containers without considering the cost was consulted during comparison evaluation, which might be a situation closer to the real world, i.e., on the market. As shown in the last part of Table 24.5, the design concepts have significant effects on the participants' purchasing decision. 'Desire' and 'Sharkie' would be purchased by most of the participants, followed by 'Mushy' and 'Passion'.

**Table 24.5** The average ratings of user evaluation on functional experience, emotional experience and willingness to purchase during the comparison evaluation

| | Mushy | Passion | Desire | Sharkie | Fresh mint | Mary biscuit | $P$-value |
|---|---|---|---|---|---|---|---|
| *Function* | | | | | | | |
| 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* | | | | | | | |
| 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* | | | | | | | |
| | 59.03 | 58.09 | **81.24** | *73.15* | 49.24 | 48.67 | 1.02E−06 |

*Note* The bold and italic values respectively represent the highest and second high average ratings.

F. **Qualitative information**

Besides the quantitative data discussed above, the participants' qualitative feedbacks were also collected. On the one hand, qualitative information can help designers have a better understanding of participants' thoughts from varied aspects of user experience rather than be limited by the choices of the answers. It also provides a chance for designers to discover customers' possible doubts and queries, which all can help designers to improve the designs and, thus, more positive experience can be created. For example, participants may query the easiness of cleaning for the brown internal surface of 'Mushy', question whether 'Passion' would fall easily especially when there are kids around, or cannot estimate the cookies' level when it is lower than the position of the eyes of 'Sharkie'. Similarly, participants may commend on some facets of the designs. Some examples are the affective value of the overflow chocolate feature of 'Mushy', which may stir up curiosity and longing; the functional value of the temporary waste storage of 'Desire' especially for outdoor activities; and the sensory design features of the mint scent of 'FreshMint', which may elicit users the feeling of freshness and remind them to brush the teeth. Furthermore, some valuable suggestions can be captured as well. For instance, while commenting on the design 'Sharkie', one participant suggested changing the way of cutting food packaging by sliding the package upwards instead of downwards. This was to avoid the contents inside packaging to leak out during the cutting process.

On the other hand, qualitative information can help designers to assess how well a participant can build a mental model of a design concept in his/her mind. Especially for a virtual situation where users are not able to interact with the physical products, it can be a factor how well a user can imagine a product and his/her potential user experience. 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'.

G. **The final design concept**

Based on the user experience and evaluation captured, a final design concept is chosen and revised. 'Desire' and 'Sharkie' have the highest voting in most of the aspects. For appearance evaluation, 'Desire' and 'Sharkie' were the most pleasant, attractive, modern, interesting and cute biscuit containers. For functional experience, 'Desire' and 'Sharkie' were selected to be the most practical biscuit containers. For emotional experience, 'Desire' and 'Sharkie' were chosen to be the most happy, inviting, active, surprise, satisfied and comfortable biscuit containers. On top of that, 'Desire' and 'Sharkie' have the highest counts in occasions which participants would use the biscuit containers. 'Desire' and 'Sharkie' once again scored highest in participants' willingness to purchase the biscuit container. Hence, 'Desire' and 'Sharkie' biscuit containers were chosen as the better design concepts among the six. In order to select the final design

**Fig. 24.16** The prototype of the final design, 'Desire'

among them, the qualitative comments given by participants were further examined. It is shown that 'Desire' can evoke more positive emotions of the participants, e.g., happy, surprise, interesting and appetizing emotions. Thus, it is chosen as the final design among the six biscuit containers for this young segment. The design of Desire was revised and improved. Based on the customer requirements captured, the way to open the temporary waste storage is changed to sliding, which is more convenient for users to open the waste storage. This also avoids biscuits crumbled when opening the waste storage. A physical working prototype is built as shown in Fig. 24.16.

## 24.5 General Discussion

The application of the CMSES and SCS can be tailored readily according to 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 is young generation and the product type of interest is biscuit container. The design team is keen to get 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 exploration' is a promising approach to help designers examine, exploit and investigate user experience in a more dedicated and robust manner.

On the one hand, the study takes individual differences into consideration when tackling multiple contextual factors. This is to ensure the experiential knowledge captured can fit into a user's real situation and, thus, be more valuable and usable. A company can decide how much the users or customers can contribute to the context settings of usage scenario(s), which will be used in the user involvement studies. In the case study, the design team uses an easy and quick way by providing several usage scenarios for participants to choose the ideal one(s) to experience the product. The advantages are fewer budgets and time consuming, as well as no extra training is required from the user side. Nevertheless, for a company that promotes innovation and creativity, users can have more opportunity and freedom to decide the customized scenarios. In doing so, design teams can be better inspired regarding how a product can be 'played' and the marketing department can also explore more potential usage scenarios for advertisement and so on.

On the other hand, due to the fact that users experience a product through all the senses, it is a good starting point for designers to deal with inherently complex user experience in a more natural way. In addition, applying multi-sensory experience exploration is like using a magnifier to examine user experience without missing any sensory aspect in order to have more complete exploration of user experience. For example, design teams can discuss the sensory experience of a certain sense in more detail to identify possible problems caused by a stimulus, and 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 (or stimuli) may affect user experience while working together (i.e., sensory interactions) to ensure the design concept may produce natural, logical and pleasing overall multi-sensory experience. In addition, designers have to ensure whether the design concepts can fit into the targeted usage scenarios after the conceptualization stage. In doing so, the design concepts created can bring users the most long-lasting positive, hedonic and rich multi-sensory experience. Thus, the design concepts generated at the second stage of the case study tend to have better user evaluation than the original design for the young segment as discussed at the third stage of the case study. In this sense, the 'context-based multi-sensory experience design' can also strengthen the experience design.

Moreover, since the knowledge regarding customers' personal sensory preference, sensory habits and ideal usage contexts can be captured, a company can better plan for its marketing and design strategies as well. Yet the application can still be very flexible depending on the project focus. Therefore, 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 with unearthing what kinds of usage contexts are the most popular for different user groups, followed by deciding 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 5 years from present and then ask users to build up their imagined future usage contexts. On the other hand, one can focus more on the multi-sensory experience and individual differences. For example, if a company wishes to implement a 'mass customization' strategy in order to expand the 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 control the manufacturing costs. As a result, in a CE/CPD environment, different departments in a company can work together better.

In a sense, the study may consume more time and cause higher budget because it suggests more input from the user or customer domain. However, it is still worth endeavor and investment for a company to implement, especially when the consumers' experience has become more and more important in this highly competitive era. In addition, this concept can be carried out at the very front end of PDD to maximise the benefits.

## 24.6 Conclusion and Future Perspectives

As the contemporary PDD process has shifted the focus of its endeavour to user-centric and consumer-oriented aspects, users or customers are often invited to contribute their views in NPD. Nevertheless, some issues would rise readily if there is lack of careful consideration of the inherent nature of user experience during user involvement studies. Based on the identified research gaps, a prototype CMSES with a SCS is introduced and demonstrated using a three-stage case study. The result is promising and shows valuable potential benefits for a company to employ the proposed 'context-based multi-sensory experience exploration and design' approach in designing and developing consumer goods. It is envisaged that, with the proposed approach, not only designers can have a more comprehensive and in-depth understanding of users' multi-sensory experience, but also product managers and marketers can better plan for the design and marketing strategies. This is

because valuable knowledge regarding individual differences in different aspects of user experience, including personal sensory habits and ideal usage contexts, can be captured.

User experience has become a crucial key to success in designing and developing consumer goods. Future studies can dedicate to investigate into different methodologies and tools to address the complex, subjective and dynamic nature of user experience and strengthen user experience exploration [58, 59]. More empirical studies are also required to demonstrate the proposed 'context-based multisensory experience exploration and design' approach and broaden the application scope by inviting more stakeholders to facilitate successful implementation of CE/CPD in the realm of PDD [60].

# References

1. Haque BU, Belecheanu RA, Barson RJ, Pawar KS (2000) Towards the application of case based reasoning to decision-making in concurrent product development (concurrent engineering). Knowl-Based Syst 13(2–3):101–112
2. Riedel JCKH, Pawar KS (1991) The strategic choice of simultaneous versus sequential engineering for the introduction of new products. Int J Technol Manage 6(3–4):321–334
3. Swink ML (1998) A tutorial on implementing concurrent engineering in new product development programs. J Oper Manage 16(1):103–116
4. Addo-Tenkorang R (2011) Concurrent engineering (CE): a review literature report. Paper presented at the world congress on engineering and computer science (WCECS 2011), San Francisco, USA, 19–21 Oct
5. Winner RI, Pennell JP, Bertrand HE, Slusarczuk MMG (1988) The role of concurrent engineering in weapon system acquisition (vol IDA report R-338). Institute for Defense Analyses, Alexandra
6. Shishko R (ed) (1995) NASA systems engineering handbook (vol. SP-610S). National Aeronautics and Space Administration, Washington
7. Chen CH, Sato K, Lee KP (2009) Human-centered product design and development. Adv Eng Inf 23(2):140–141
8. Sanders EBN (1999) Postdesign and participatory culture. Paper presented at the useful and critical: the position of research in design, Tuusula, 9–11 Sept
9. Nagamachi M (2002) Kansei engineering as a powerful consumer-oriented technology for product development. Appl Ergon 33:289–294
10. Chen CH, Yan W (2008) An in-process customer utility prediction system for product conceptualisation. Expert Syst Appl 34(4):2555–2567
11. Hende EA, Schoormans JPL (2012) The story is as good as the real thing: early customer input on product applications of radically new technologies. J Prod Innov Manage 29(4):655–666
12. Yan W, Chen CH, Chang W (2011) A functional—commercial analysis strategy for product conceptualization. Expert Syst Appl 38(8):9879–9887
13. Carbonell P, Rodriguez-Escudero AI, Pujari D (2009) Customer involvement in new service development: an examination of antecedents and outcomes. J Prod Innov Manage 26(5):536–550
14. Pine BJ, Gilmore JH (1998) Welcome to the experience economy. Harvard Bus Rev 76(4):97–105
15. Pine BJ, Gilmore JH (1999) The experience economy: work is theatre and every business a stage: goods and services are no longer enough. Harvard Business School Press, Cambridge

16. Boven LV, Gilovich T (2003) To do or to have? That is the question. J Pers Soc Psychol 85 (6):1193–1202
17. Djajadiningrat JP, Overbeeke CJ, Wensveen SAG (2000) Augmenting fun and beauty: a pamphlet. Paper presented at the DARE 2000: designing augmented reality environments, Helsingor, 12–14 Apr
18. Gilovich TJCT (2010) The Relative Relativity of Material and Experiential Purchases. J Pers Soc Psychol 98(1):149–159
19. Hassenzahl M, Tractinsky N (2006) User experience—a research agenda. Behav Inf Technol 25(2):91–97
20. Desmet P, Hekkert P (2007) Framework of product experience. Int J Des 1(1):57–66
21. Hekkert P, Schifferstein HNJ (2008) Introducing product experience. In: Schifferstein HNJ, Hekkert P (eds) Product experience. Elsevier, Amsterdam, pp 1–8
22. Stappers PJ, Hv Rijn, Kistemaker SC, Hennink AE, Visser FS (2009) Designing for other people's strengths and motivations: three cases using context, visions, and experiential prototypes. Adv Eng Inform 23(2):174–183
23. Buchenau M, Suri JF (2000) Experience prototyping. Paper presented at the 3rd conference on designing interactive systems: processes, practices, methods, and techniques, Brooklyn, New York
24. Rodrigues C, Hultén B, Brito C (2011) Sensorial brand strategies for value co-creation. Innovative Mark 7(2):40–47
25. Law ELC, Roto V, Hassenzahl M, Vermeeren APOS, Kort J (2009) Understanding, scoping and defining user experience: a survey approach. Paper presented at the 27th international conference on human factors in computing systems, Boston, 4–9 Apr
26. Chen NF, Chen CH, Khoo LP Foo C (2012) investigation into dynamic multi-sensory product experience based on online shopping. In: Stjepandić J, Rock G, Bil C (eds) Concurrent engineering approaches for sustainable product development in a multi-disciplinary environment, (2013). Proceedings of the 19th ISPE international conference on con-current engineering. Springer, London, pp 897–908
27. Chen NF, Ho CH, Ma MY (2011) 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
28. Fenko A, Schifferstein HNJ, Hekkert P (2010) Shifts in sensory dominance between various stages of user-product interactions. Appl Ergon 41:34–40
29. Jakesch M, Zachhuber M, Leder H, Spingler M, Carbon CC (2011) Scenario-based touching: on the influence of top-down processes on tactile and visual appreciation. Res Eng Des 22 (3):143–152
30. Hummels C, Djajadiningrat J, Overbeeke C (2001) Knowing doing and feeling : communicating with your digital products. Paper presented at the Interdisziplinäres Kolleg Kognitions und Neurowissenschaften, Günne am Möhnesee, 2–9 Mar
31. Hekkert P (2006) Design aesthetics: principles of pleasure in design. Psychol Sci 48(2):157–172
32. Huang Y, Chen CH, Khoo LP (2012) Products classification in emotional design using a basic-emotion based semantic differential method. Int J Ind Ergon 42(6):569–580
33. Norman, DA (2004) Emotional design: why we love (or hate) everyday things. Garden City Publishing Ltd
34. Chen CH, Khoo LP, Yan W (2006) An investigation into affective design using sorting technique and Kohonen self-organising map. Adv Eng Softw 37(5):334–349
35. Khalid HM, Helander MG (2006) Customer emotional needs in product design. Concurrent Eng Res Appl (CERA) 14(3):197–206
36. Huang Y, Chen CH, Khoo LP (2012) Kansei clustering for emotional design using a combined design structure matrix. Int J Ind Ergon 42(5):416–427
37. Lee S, Harada A, Stappers PJ (2002) Design based on Kansei. In: Green WS, Jordan PW (eds) Pleasures with products: beyond usability. Taylor and Francis, London, pp 219–230

38. Nagamachi M (1995) Kansei engineering: a new ergonomic consumer-oriented technology for product development. Int J Ind Ergon 15:3–11
39. Schifferstein HNJ, Cleiren MPHD (2005) Capturing product experiences: a split-modality approach. Acta Psychol 118:293–318
40. Schifferstein HNJ, Spence C (2008) Multisensory product experience. In: Schifferstein HNJ, Hekkert P (eds) product experience. Elsevier, Amsterdam, pp 133–161
41. Spence C (2011) Managing sensory expectations concerning products and brands: capitalizing on the potential of sound and shape symbolism. J Consum Psychol 22(1):37–54
42. Bloch PH (2011) Product design and marketing: reflections after fifteen years. J Prod Innov Manage 28(3):378–380
43. Lindstrom M (2005) Brand sense: build powerful brands through touch, taste, smell, sight, and sound. Free Press, New York
44. Schifferstein HNJ, Desmet PMA (2007) The effects of sensory impairments on product experience and personal well-being. Ergonomics 50:2026–2048
45. Holmes NP, Sanabria D, Calvert GA, Spence C (2007) Tool-use: capturing multisensory spatial attention or extending multisensory peripersonal space? Cortex 43(3):469–489
46. Zomerdijk LG, Voss CA (2011) NSD processes and practices in experiential services. J Prod Innov Manage 28(1):63–80
47. Edvardsson B, Olsson J (1996) Key concepts for new service development. Serv Ind J 16 (2):140–164
48. Rijn Hv, Stappers PJ (2008) Expressions of ownership: motivating users in a co-design process. Paper presented at the 10th anniversary conference on participatory design, Bloomington
49. Go K, Carroll JM (2004) The blind men and the elephant: views of scenario-based system design. Interactions 11:44–53
50. Schifferstein HNJ (2006) The perceived importance of sensory modalities in product usage: a study of self-reports. Acta Psychol 121:41–64
51. Spence C (2002) The ICI report on the secret of the senses london: imperial chemical industries plc. The Communication Group, London
52. Schifferstein HNJ, Desmet PMA (2008) Tools facilitating multi-sensory product design. Des J 11(2):137–158
53. Citrin AV, Stem DE, Spangenberg ER, Clark MJ (2003) Consumer need for tactile input: an internet retail challenge. J Bus Res 56:915–922
54. Durlach NI, Mavor AS (eds) (1995) Virtual reality: scientific and technological challenges. committee on virtual reality research and development. National Research Council, Washington
55. Klatzky RL, Pai DK, Krotkov EP (2000) Perception of material from contact sounds. Presence 9(4):399–410
56. Kunkler-Peck AJ, Turvey MT (2000) Hearing shape. J Exp Psychol Hum Percept Perform 26 (1):279–294
57. Peck J, Childers TL (2003) To have and to hold: the influence of haptic information on product judgments. J Mark 67(2):35–48
58. Chang D, Chen CH (2014) Understanding the customer involvement in radical innovation. In: Bil C et al (eds) Proceedings of 20th ISPE international conference on concurrent engineering. IOS Press, Amsterdam, pp 72–80
59. Chang D, Chen CH (2014) Understanding the influence of customers on product innovation. Int J Agile Syst Manag 7(3/4):348–364
60. Chang D, Chen CH (2014) Exploration of a concept screening method in a crowdsourcing environment. In: Cha J et al (eds) Moving integrated product development to service clouds in global economy. Proceedings of the 21st ISPE Inc. international conference on concurrent engineering. IOS Press, Amsterdam, pp 861–870