

Designing a Cross-Cultural Interactive Music Box through Meaning Construction

Yongmeng Wu¹, Nick Bryan-Kinns¹, Wei Wang^{2,4},
Jennifer G. Sheridan³, and Xiang Xu⁴

¹ Media & Arts Technology, Queen Mary University of London, London, UK

² School of Industrial Design, Georgia Institute of Technology, Atlanta, GA, US

³ b00t Consultants Ltd, UK

⁴ School of Design, Hunan University, Changsha, PRC

yongmeng.wu@qmul.ac.uk

Abstract. There is growing interest in designing culturally identifiable products for cross cultural consumers. However, literature rarely pays attention to the conflicting needs of these products in terms of cross-cultural usability and their unique cultural identity. This paper presents a design model addressing this problem through a process of meaning construction. By identifying the culture's shared and unique meaning, designers are able to map the target meaning onto the product attributes - the form, content and interaction - thus presenting culturally identifiable and cross-culturally acceptable products to culturally heterogeneous consumers. A case study of designing a meaningful cross-cultural interactive music box with the Kam ethnic minority culture is presented focussing on the detailed process of meaning construction, and implementation and evaluation. Feedback in the field showed that the shared meaning built in the boxes helped outsiders to understand the interaction. The unique meaning helped to attract the attention from participants outside Kam culture, and improved the cultural identity. The results also showed that participants from different culture preferred different product features, for example the story content attract participants outside Chinese culture, while Chinese participants preferred playful interaction on the sound.

Keywords: Meaning Construction, Cross-cultural Design, Product Identity, Interactive Music, Design Method

1 Introduction

Many regional cultural and traditional communities in China are suffering from transformation because of rapid urbanisation [1]. One of the key challenges that traditional rural communities encounter in modern society is the preservation and maintenance of their original social capital [2]. This issue leads to an important topic of this paper related to design practice: how to preserve and promote traditional cultural heritage of rural communities in the digital age in order to sustain and improve local peoples cultural identity, as well as to stimulate local

economic development? Cultural product design offers solutions by transforming and intensifying traditional cultural feature in consumer products or tourist souvenirs. By embedding local cultural features and emphasising cultural value in product design, product value is enhanced, as well as its identity in the global market [4]. However, an emerging problem for these exotic souvenirs is that culturally diverse users might encounter cultural breakdowns [6], which is especially true for interactive products or systems due to representational variations between cultures [7].

Informed by the “Meaning in Mediated Action” approach of cross-cultural HCI design [7] which highlights the role of “shared meaning” in broad contexts and its use as a base to design shared representations, this paper proposes a more detailed framework integrating the idea of “shared meaning” with “unique meaning” for the purpose of supporting the design of product usability as well as cultural identity across different cultures. Following the design model, this paper presents a case study of designing interactive cultural products for cross-cultural consumers in a remote minority community, detailing the process of designing two meaningful interactive music boxes through identifying the “shared meaning” and “unique meaning” and mapping them to the product attributes: form, content, interaction. By engaging designers with a local community to acquire cultural knowledge, and encouraging innovation from local craftsmen in the design process, two prototypes were designed and implemented in a local mobile maker space using local materials. An agile evaluation method collecting ‘in-situ’ feedback for further design iterations was carried out with local residents and tourists, followed by a more formal evaluation in London (UK) when the boxes were displayed in a public exhibition. Questionnaires were collected at the exhibition with participants outside Kam culture. Results showed that shared meaning helps outsiders to understand the product interaction, and improved the cultural identity. The results also showed that participants from different culture preferred different product features, for example the story content attract participants outside Chinese culture, while Chinese participants preferred playful interaction on the sound. The model offered a clear idea from the beginning to guide the process on designing a cross-cultural interactive product. And also, it gave a structure to organise the evaluation, by analysing the effectiveness of the two-layer meaning as well as the design attributes.

2 Design Objectives and Methods

2.1 Meaning in Cross-Cultural Design

Meaning is proposed as a central factor in design practice for cross-cultural products for the following two major reasons:

- First of all, meaning construction is an ongoing activity of people when they talk, think and act in everyday situations [5]. Research from Markussen and Krogh [9] focuses on the dynamic process when people creatively reshape and transform pre-existing cultural knowledge when they encounter a new

digital artefact that has unexpected structures of experience, or conflicts with their previous knowledge. They use blending theory as a new conceptual framework to unpack the internal configurations and governing principles of meaning construction. Therefore, designing cross-cultural products need to consider the process of user’s meaning construction.

- Secondly, communicating meaning is an approach to avoid the culturally determined usability problems of products for culturally heterogeneous users [7]. [8] addresses issues related to product internationalisation and localisation, approaches for designing interfaces for cultural diverse users in early 1990s, through studies of the usability and user experience of interactive interfaces across diverse cultures. The common limitation of this process is that culturally diverse users often encounter cultural breakdowns, “the moment when the user becomes conscious of the properties of the system and has to mentally break down or decompose his or her understanding of the system in order to rationalise the problem experienced” [6].

Through analysis of user’s cultural breakdowns, Bourges-Waldegg and Scrivener identified the fundamental problem of designing interfaces for culturally diverse users is to communicate the intended meaning of representations in different cultural contexts [7]. They presented the “meaning in mediated action (MMA)” approach to tackle the main usability issues determined by cultural difference in Human-computer interaction cross-cultural design. This approach starts by determining the contexts shared by the members of a culturally heterogeneous user group and use these as a base to design shared representations. The MMA approach focuses on how representations and meaning mediate action, putting *shared meaning* in the centre position to be a tool for understanding as well as an analytical tool.

In contrast to the emphasis on shared meaning outlined above, studies also indicate the importance of *unique meaning*. For example, Rampino proposed meaning innovation in the process of product innovation [10]. Meaning innovation here concerns the emotional and symbolic aspects of a product, i.e. what a product is able to communicate, which is strictly linked to its cultural context. This is very close to the concept of *design icon*, that “products that gather a cultural meaning that is greater than the sum of their specifications” [11]. As a result of meaning innovation, the product becomes culturally successful. The idea of *unique meaning* is also highlighted as a key point to promote cultural identity and product value in the field of cultural product design described in the following section.

2.2 Cultural Product Design

As opposed to the trend of internationalisation and localisation on global products, an emerging trend is designing cultural product to promote local cultural identity and enhance cultural values and traditions, because “the search for identity includes claiming the right to maintain different values” [14]. Besides the benefit of creating and sustaining cultural identity, emphasising product local

features and cultural value has become a critical issue in the design process. It helps to transform traditional objects into modern products that meet the needs of the contemporary consumer market, and in turn helps to enhance product value in the global market [16]. It can also enhance individual experience and memory, and trigger a culture reflection of customers [15].

One branch of study in this field focuses on analysing the cultural factors related to design. The study of cultural layers has expanded from a two-layer framework (visible, and invisible) [23], to a three-layer framework (basic assumptions, values, and artefacts) [24], and finally towards a four-layer framework [25], including the first layer of basic assumptions and values, the second layer of beliefs, attitudes and conventions, the third layer of systems and institutions, and the fourth layer of artefacts, products, rituals and behaviour [26]. Other studies started to relate the cultural levels to attributes of cultural objects. For example, Leong and Clark distinguished three special levels of cultural objects: the outer ‘tangible’ level, the mid ‘behavioral’ level, and the inner ‘intangible’ level [22]. Moreover, Hsu et. al. provided detailed cultural factors relating to design attributes: the outer level dealing with colors, texture, form, decoration, surface pattern, line quality, and details; the mid level containing function, operational concerns, usability, and safety; the inner level containing special content such as stories, emotion, and cultural features [19].

Another branch of study focus on methodology for designing cultural products to transform and encode unique culture factors. A culture-centred design approach was proposed by [17] with a cultural filter in order to improve the usability and allow cultural identity, meaning, values and tradition to be truly integrated and conveyed. Similarly, Richie proposed a culture-oriented model to combine and break down the contemporary socio-cultural factors into material, emotional, social practice and technology/design factors [26]. Wang et. al. addressed traditional craft and modern design collaboration in brocade products [3]. Tung suggested co-creation as a method to stimulate the development and preservation of a local craft in a sustainable and commercially viable way [18]. Lin provided four steps to design a cultural product, including investigation, interaction, development, and implementation using scenario and story-telling approaches to access to social background, resource constraints and background information [16]. In a later paper, the four phases of cultural product design were expanded into a ten steps framework [19]. Wang et. al. summarised three social design paradigms for cultural product design [31]: i) cultural intermediaries paradigm which mainly adopts quasi-ethnographic approaches, such as participatory observation, interviews and cultural inquiries; ii) the product-service system paradigm which adopts an artefact oriented development process that with methods such co-design, participatory design; and iii) the community engagement paradigm which adopts an event-driven process, applying in-situ and iterative techniques such as cultural probes and community performance.

The studies discussed above on cultural factors offered an idea to construct the meaning, including both *shared meaning* and *unique meaning*, through the product attributes in the proposed model. This allows the meaning construction

model to offer operationable guidance in design practice. The methods proposed in this field are mainly focused on extracting and encoding the unique culture factors, with less attention on the identifying and implementing the shared meaning. Therefore our proposed model will offer an approach addressing both aspects, as well as an case study illustrating detailed process.

3 Meaning Construction - A Design Model

There are clearly two conflicting needs which emerge in terms of *meaning* when considering the design of a commercial souvenir product from both a cross-cultural product design and the cultural product design perspectives:

- A need for *shared meaning* related to cultural factors, context and representations that culturally diverse users share in order to ensure product understandability and usability across cultures.
- A need for *unique meaning* related to the tangible, behavioural, and intangible culture factors that the culture uniquely possessed so as to cherish and promote the culture.

Therefore, based on the idea of highlighting the role of *shared meaning* from the MMA approach, we proposed to integrate *unique meaning* in cross-cultural product design as a source for meaning innovation.

Building on the cultural factors of cultural products discussed above, we propose three more specific cultural attributes of interactive products: interaction, form, and content. The *interaction* includes the functions, operations, and actions of product, which is directly related to the behavioural level of culture, including cultural factors such as behavioural norms, beliefs, concerns etc. The *form* includes shape, color, material, texture, patterns of product, which is linked with the tangible level of cultural. The *content* includes the visual, sound and emotion experience of product, and is bounded with the intangible level of culture, including the cultural factors such as sound, stories, and emotions.

We propose a model for designing cultural interactive products through mapping the *shared meaning* and *unique meaning* with the design attributes of the interactive systems that relates to the different culture levels, see Figure 1. Specifically, the mapping involves, on one hand, constructing shared meaning through a process of identification of shared representations, contexts, or factors with relation to the interaction, form and content. On the other hand, the mapping involves constructing unique meaning of product through a process of extraction of featured culture factors in terms of the interaction, form and content. It is necessary to note that the mapping between the meanings and the product attributes are not fixed, the mapping can be varied according to different culture and different products. The idea of mapping the two-layer meaning into product attributes is to construct the abstract meaning through concrete design attributes, in order to offer designers an implementable model to construct the product's meaning.

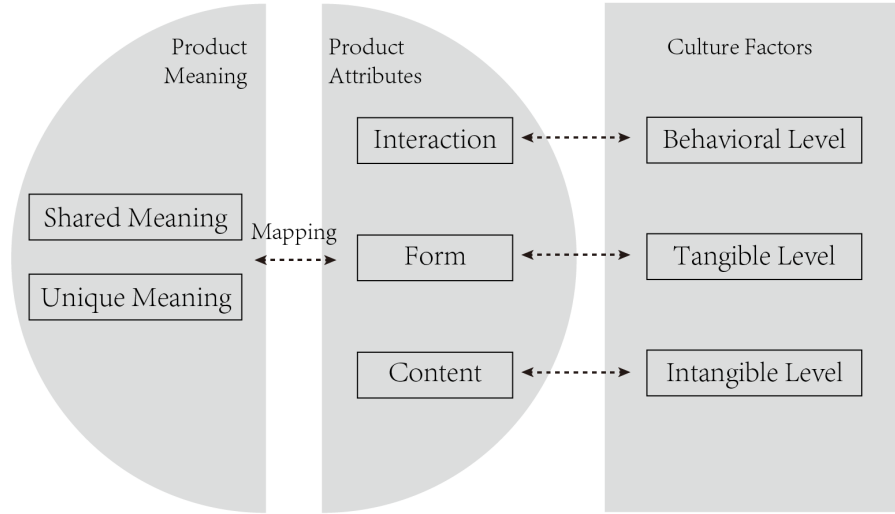


Fig. 1. Model of Meaning Construction

4 Case Study: a Meaningful Cross-Cultural Interactive Music Box

The Kams minority culture is from their community in Tongdao county in Hunan province, central south China. Their culture is unique and famous for their wooden buildings with exquisite structures, their ethnic music, instruments, their carpenter skill of wooden products, and their local customs [31]. With their unique and well preserved traditional culture, Tongdao has attracted numerous tourists from other regions of China as well as foreigners from across the world in recent years, which has greatly helped local economic development. An emerging need is a range of high quality souvenirs to enhance the souvenir product value as well as to promote the local cultural identity. Researchers have focussed on this issue since 2009 through the engagement with the Kams minority culture [1][3][31]. In the summer of 2016, a concentrated exploration based on long-term research concerns was carried out focusing on designing a meaningful cross-cultural tourist souvenir, which is reported here.

As mentioned above, music and musical instruments are a very important factor in Kam culture. Meanwhile, the music box is a traditional western artifact - a kids toy and romantic gift often with craft patterns and physical interaction - which is now a familiar object for Chinese people as well. With the rapid development of sensors and digital sound technology, numerous interactive music boxes have been built with various interactions in various forms, both commercially and including a series tangible objects designed for collaborative group playing [27] [28], and a series of performative objects for live musical performance [29]

[30]. Our idea in this work is to merge interactive technologies and industrial design methods to develop a new musical consumer product for domestic tourist markets and for those who seek a new and exotic souvenir.

4.1 Design Process

Cultural Exploration The design process started with an open ended exploration of local culture to help designers to understand and study new environments, and generate inspirational data to inform the design process. Four aspects of design were asked to look at when collecting local inspirations: Culture, Interaction, Form, and Sound. It offers a general structure for designers to explore and pay attention to during this process. As the main local challenges that designers meet during design process is to gain the local knowledge [1], cultural exploration is a necessary step for designers to overcome the knowledge barriers and cultural boundaries [31]. Two designers in our group, together with five designers in the other groups, set out with cameras to local villages, took pictures of the land marking architectures such as their memorial gateway, tower bridge, and drum tower, and interviewed local people about their handicraft and articles for daily use. The basic target for this activity was to engage with the local community, gain local cultural knowledge, and to identify the unique culture factors as well as the shared culture factors.

Through two days of cultural exploration at Kam culture, we found a traditional local object, Lucky Flower, which is a blessing hung in the beams of symbolic buildings, such as the village gate, the drum tower, or the tower bridge in Kam communities. The Lucky Flower is a set of colourful patterned boxes in geometric shape organized with wire in hierarchy layers, see Figure 2. Whenever a new building is completed, Kam people will hang several Lucky Flowers on the roof to pray for bless to the building. Usually they are made by local grandmas voluntarily with recycled cardboard and knitting wool. We found the Lucky Flower is a symbolic culture object, as well as a suitable archetype for music box with modern form and design. Therefore it is used as a design archetype to extract unique cultural meaning for our target interactive music box.

Unique Meaning Construction In our case the unique meaning is extracted from the cultural symbolic object, the Lucky Flower, to support the identity of the product. For our target music box we constructed the unique meaning based on the form and content, see Figure 3. The basic shape, color and pattern of Lucky Flowers are unique Kam cultural factors which we extracted as the form of our target music box. Although one set of Lucky Flower consists of several layers of geometry boxes lined with strings, the geometric shape across the layers are the same, differed in size. The hollow square pattern twined with wool thread on Lucky Flower represent good luck in Kam culture. The bright green and red color on Lucky Flowers are typical Kam colors as featured in their cloth and fabrics. Therefore, the basic geometry shape, the color and the patterns were adopted as the form for our target music box as a unique meaning component.



Fig. 2. Original Lucky Flower

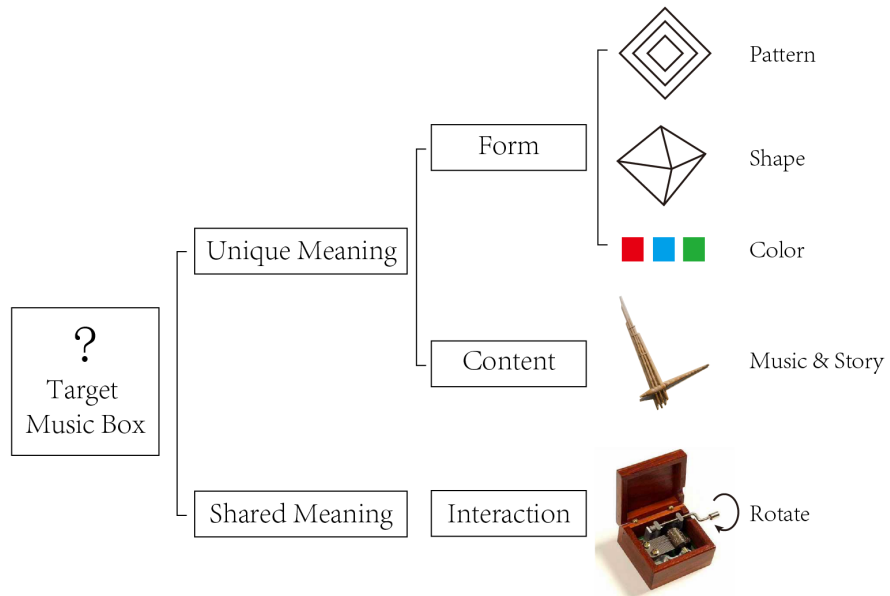


Fig. 3. Structure of Meaning Construction

In terms of the content, Kam music is a famous and exquisite ethnic feature that tourists find novel. Also, the stories of Kam culture as well as the stories of Lucky Flower are an interesting and unusual content source for outsiders. Therefore, we adopted Kam music and Kam stories as the content of target music box - another unique meaning component.

Shared Meaning Construction As outlined in the previous section, an important step is to construct a shared meaning, as well as a unique meaning, by examining the shared cultural factors, contexts, representations between the music in Kam culture and the target product - the music box.

For traditional music box, a typical interaction is to rotate the small handle somewhere on the box to trigger the music. For Chinese people, the rotation action of traditional music box is a familiar concept. In the Kam tourist market in Tongdao there are conventional music boxes for sale, all of them include such rotating interaction. Moreover, rotation is also a familiar behaviour in everyday life of Kam culture. For example, when the weaver preparing the thread, rotation is a repetitive action. Besides, when Lucky Flowers are hung on the roof of the tower bridge or drum tower, they rotate in the wind. Based on this shared knowledge, rotation was adopted for the basic interaction of our new music box as a component for shared meaning, with the aim of supporting understandability as well as usability, see Figure 3.

Product Attributes	Story Box	Music Box
Interaction (Shared Meaning)	Rotate to switch between stories	Tilt to switch between music & Rotate to add live sound effect
Form - Shape (Unique Meaning)	Lucky Flower	Lucky Flower
Form - Color (Unique Meaning)	Cultural color (Red/Green)	Normal color (Pink/Blue)
Content	Stories of Lucky Flower	Local Music

Table 1. Comparison of two boxes

Comparative Music Box We decided to build two music boxes with slightly differed features to allow us to make a comparison of the effectiveness of our proposed design method. A comparison of the two boxes is given in Table 1. The first box, the *story box*, was built on a rotatory interaction, with red/green color, and with the content of stories of lucky flower.

The comparative box, the *music box*, used tilt as the primary interaction. Instead of rotating the knobs, users can tilt the box to certain angles to switch between sounds. The idea of tilt came from the shape of lucky flower. The six sides of the shape offer the affordance of tilting when holding it in a hand. However, there is no shared meaning being built here. In terms of the form, the

music box has with the same shape as the first. However, in terms of the color, a light pink and blue, which is an unusual color for Kam culture, were chosen for comparison. Informed by the novel interactive music systems mentioned earlier [27] [28] [29] [30], a playful feature to add real-time sound effects to the music was designed. Rotation is adopted as a secondary interaction here for this feature. Whenever users rotated the knob, the pitch of the music will be randomly changed within a certain range which creates an interesting sound effect.

4.2 Implementation

The working prototypes are shown in Figure 4. The red/green box is the *story box* with three rotatory knobs around the perimeter to switch between stories. The pink/blue is the *music box* with tilt interaction to switch between pieces of music and one nob on top to add live sound effect by rotating.



Fig. 4. Two design of Kam Tunes

The implementation involved three parts: i) the form implementation that involves the physical model of the boxes; ii) the interaction implementation that involves the electronic sensors and software; iii) the content implementation that involves the stories and music. The making process is illustrated in figure 5.

When designing the form and content of both boxes we conducted an iterative process of co-creation with local people. We learned from local grandmas to make the shape with recycled cardboard. Together with their knowledge of cultural color and patterns, we chose the color of wool thread and learned to wrap the box in the cultural pattern. We interviewed local grandmas about the history of

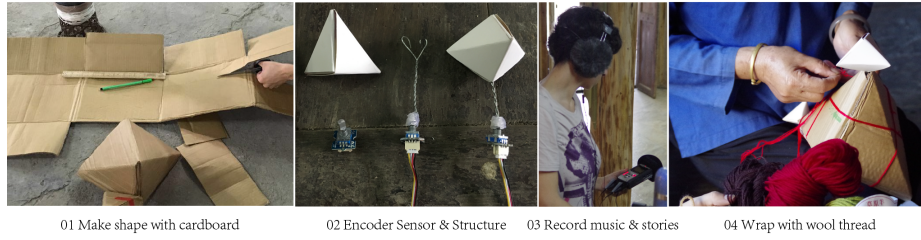


Fig. 5. Making Process

Kam culture and Lucky Flower. Three stories were extracted from their story telling. We also recorded local music with folk artists and collected three pieces of music.

In terms of the interaction, we built the system with sensors, material and tools in a workshop space for social innovation located in the local village [31]. For the *story box* that adopted rotatory interaction, three rotary encoder sensors were assembled with iron wire in the corner of the box so that the users could rotate the knobs to choose and switch between the stories. An Arduino board [32] is used to get the data from sensors, together with a sound board to play the sound with a micro-speaker. All of these items are embedded in main body of the *story box*.

For the *music box* that adopted tilting interaction, three tilt sensors were glued on the top inner sides of the box so that when the box is tilted to certain angle, one piece of music will be triggered. A rotatory encoder sensor was assembled on top of the box to control a live sound effect of pitch changing. An Arduino board was used to process the data from sensors. The sound program was written in Processing language. To run this box, the Processing sketch needed to be run on a connected computer to play back the sound.

5 Evaluation

An agile evaluation in the local setting which collected 'in-situ' feedback for further design iterations were conducted with tourists in local tourist market and with local residents in the village. We started by introducing the two boxes, then encouraged participants to play with the two boxes for a while, followed by simple interview questions. Due to the time constraints, only a limited number of participants were involved in this process.

Two months later the two boxes were displayed at a public exhibition in London. We started by introducing the background of Kam culture and the two boxes to visitors. They were then asked to play with the two boxes for a while, followed by filling in a simple questionnaire. The questionnaire asked participants to rate statements based on their agreement on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). There are 7 statements, including:

(S1) I prefer the Red prototype in general; (S2) The interaction of Red prototype is more intuitive than the Pink prototype; (S3) The Red prototype is more fun than the Pink prototype; (S4) The sound of Pink prototype is more expressive than the Red prototype; (S5) I feel more engaged with the Pink prototype; (S6) I feel more creative with the Pink prototype; (S7) I like adding live sound effect on the sound. Field notes were taken by the researcher whilst participants were playing with the boxes to record their questions, judgements, attitude, as well as the researcher's observations of participants' behaviour and interaction.

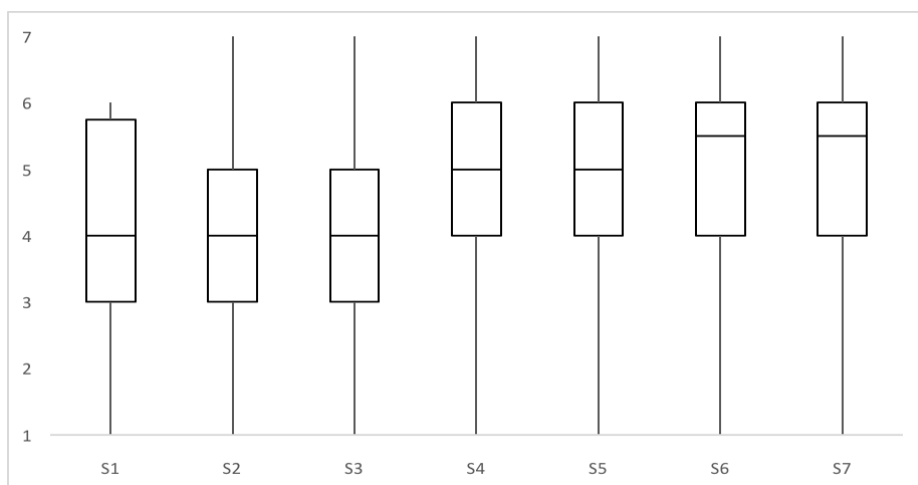


Fig. 6. Box Plot of Questionnaire from London Exhibition

5.1 Results

In the local evaluation, five local participants (two adults and three children, all Chinese) were given the boxes to play with and interviewed afterwards, each of them interacted with the boxes for around 5 minutes in total. Two children and two adults liked the *music box* because they found the sound effect is more playable than the *story box* without the real-time sound effect. They also reported that the stories are not interesting because they are quite familiar with the stories. One child liked the *story box* because he thought it looks like a spaceship with the three nobs around the big shape. Three tourists (one adult and two children, all Chinese) from outside Kam culture were also interviewed, following the same procedure as the previous one. One child liked the *story box* because of its shape and colour, the others liked the *music box* because it's more playable with the real-time sound effect, and because the stories becomes boring after a while of playing.

The observational results reveals interesting behaviours of the participants. For example, majority kids (four out of five) started laughing when they heard the sound was twisted because of the real-time sound effect whiling rotating the nob on the *music box*. Two of them started rotating the nob even faster to test the effect on the sound. This behaviour showed that the real-time sound effect triggered the kids' interest to play with the sound. Moreover, two local kids were curious about the sound from the box that they examined the box all over. They asked questions such as "why is there sound coming out from the box" and "why does the sound changing". The *music box* gave them surprise with the embed interactive technology in the traditional symbolic object.

A total of 34 questionnaires were collected at the public exhibition in London (17 female and 17 male, mean age = 30, sd = 8.91, 5 Chinese). A box plot was generated from the questionnaire data as shown in Figure 6. In general, our participants were neutral regarding their preference between the two prototypes. There is also no obvious preference in terms of the interaction. In terms of the engagement and creativity, participants preferred the *music box* with the feature of playing with live sound effect.

Review of the field notes reveals interesting behaviour by the participants with respect to the interaction and content of the boxes. For example, there are observations related to the interaction: "participant said that 'the red interaction is more intuitive, self-explanatory'", "participant feel the red prototype is easier to understand in the first place", "participant was squeezing the Pink prototype and thought it works in that way", which suggests that the rotatory interaction is easier to understand for users. Moreover, there are observations related to the content, "participant was more interested in the stories in the story prototype", "participant prefer the red prototype more because the content is more interesting", "participant played longer with Pink prototype". These statements suggest that the story content is attractive despite the significant language barrier.

There is no evidence suggesting the color of the boxes affect participants' preference between the boxes in the second evaluation. However, this is quite different compared to the opinions of local grandmas, who helped us to build and wrap the boxes. When chose the color for the second comparative box (the *music box*), all grandmas at presence (six of them) insisted using local cultural color such as bright red, green, blue, etc. For the purpose of comparison for later evaluation, we tried to avoid using the cultural color for the *music box*, which was clearly not the good choice for the grandmas, as they described our chosen color 'uggly' and kept persuading us to change to their traditional color. Although later the feedback from participants outside local culture indicated that the color made no difference, according to the grandmas' attitude, it seems that the product identity is reduced with non-traditional color from local people's perspective.

6 Further Discussion

In general, six amongst eight participants in the local evaluation liked the *music box*. However, feedback showed that there were more participants from foreign countries interested in the *story box* because of the story content. Some of the foreign participants expressed strong interest in listening to the stories even though they could not understand the language at all. They were also willing to learn the history of Kam culture while listening to the box. This preference is completely opposite compared to the participants in China, who reported the stories became boring after awhile. A possible reason for this is that narrative story telling is a common form of knowledge sharing across cultures, which might be a hidden shared meaning we as designers didn't realise in the beginning.

The shape of the box is so distinctive and exotic that it attracted foreign participants' interest instantly at first sight, according to the results from the exhibition. Most of them spoke highly on the aesthetics of the shape for both boxes. Moreover, it triggered participants' interest in the Lucky Flower itself - they were curious about the original form, its material, the process of making and its function. From this we can see that embedding culturally unique meaning in product supports the cultural identity. It is also interesting to note that the *story box* was favoured by two Chinese kids because of its form, i.e. its shape is similar to the spaceship.

In terms of the interaction, more participants figured out the rotatory interaction of the *story box* compared to the tilt interaction of the *music box*, according to the observation at the symposium. Moreover, five participants spoke highly on the rotatory interaction as it is "straightforward" and "expressive". This can be explained with the affordance theory [33], that the form of rotatory knobs gave an affordance of operation. Instead of pulling or pressing, most participants figured out the rotatory interaction without much effort. It seems that the rotatory interaction was more intuitive and made more sense to the participants. This evidence leads to the conclusion that the shared meaning in our design, the rotatory interaction in traditional western music box, helped participants to understand the interaction of the *story box*.

The above discussions of the results in relation to the music boxes' content, form and interaction, suggest that the two-layer framework of meaning and its mapping helped the prototypes to be understood by participants outside the local culture, whilst also helped to preserve the cultural identity. This two-layer meaning construction model is a complement of the MMA method [7] that only addressed the culturally determined usability problems. It addressed the problems related to cultural identity by integrating the theories and methods of cultural product design [22][23][25][26] to satisfy the culturally heterogeneous consumers. The model offered a clear idea from the beginning to guide the process on designing a cross-cultural interactive product. And also, it gave a structure to organise the evaluation, by analysing the effectiveness of the two-layer meaning as well as the design attributes.

There are limitations to these findings, however. As the target was to design a mass production tourist souvenir, one important issue is the material of product,

as it is important for the traditional and urban communities to encourage social practice “from a sustainable perspective to promote traditional cultural heritage and the rational use of the environment and natural resources” [1]. Although in our case study we used the recycled cardboard following local grandma’s practice, we did not take the material and mass production into account in the design model. Therefore, for future work, it would be necessary to take the material and its environmental friendliness into consideration, and expand the current model toward a more practical guidance. Moreover, the evaluations were undertaken with limited participants, especially the agile one at local. In that case, our results may not truly represent the preference of the majority of people. A larger scale and more formal evaluation needs to be conducted in future work. Besides, as we found there are diverse preference between Chinese tourist and foreigners, it would be useful to go further and study the different preference, which will be another useful guidance for designers.

7 Summary

In this paper we presented a model for designing meaningful cross-cultural interactive products through a process of two-layer meaning construction. By identifying the culturally shared and unique meanings, designers will be able to map the target meaning onto the product attributes - form, content and interaction. In this way, it is possible to design a product that is culturally identifiable and also cross-culturally acceptable.

A case study of designing a meaningful cross-cultural interactive music box for Kam culture was described. The detail of the meaning construction process, implementation and evaluation was presented. Feedback showed that the feature built on shared meaning helped the outsiders of a local community to understand the interaction, whilst the feature built on unique meaning helped the product to preserve the cultural identity, and thus trigger participants’ interest in the local culture. The results also showed that participants from different culture prefer different feature of the sound, for example the story content attract participants outside Chinese culture, while Chinese participants preferred playful and interactive features of the sound. The positive results suggests that the design model presented in this paper has practical implications in terms of guiding design practice for cross-cultural products. Moreover, it also has implications for the evaluation of cross-cultural design outcomes.

Future work will continue to explore the role of material in the proposed design model from the perspective of sustainable development, and will also explore a larger scale evaluation of this design model.

8 Acknowledgements

This work was made possible by Prof. Ji Tie, and the DESIS Research Center at Hunan University, China. We kindly thank the grandmas in Hengling village, and the participants in our study. This work is partly supported by the the

China Scholarship Council, the Centre for Digital Music EPSRC Platform Grant (EP/K009559/1), the EPSRC and AHRC Centre for Doctoral Training in Media and Arts Technology (EP/L01632X/1), and the Hunan S&T International Collaboration Program (2015WK3029).

References

1. T. Ji, Q. Yang, and W. Wang. "Design and social innovation. Design practice and methods based on networks and communities." *Product-service system design for sustainability* (2014): 345-360.
2. Liu, Li-Wei. "Reflections on community empowerment: consideration of urbanrural differences, perspectives of urban development, and exploration of the bottom-up concept." *Journal of city and planning* 35.14 (2008): 313-338.
3. W. Wang, T. Ji, and M. Jaafarnia. "Positioning Designers into the Craft Revival of Emerging Markets: A Case Study on Chinese Ethnic Brocade Industry." *Proceedings of the 19th Design Management Conference*, 2014.
4. Wu, Tyan-Yu, Hong Cheng, and R. Lin. "The study of cultural interface in Taiwan Aboriginal Twin-Cup." *HCI INTERNATIONAL*. 2005.
5. Fauconnier, G., and Turner, M. *The way we think: Conceptual blending and the minds hidden complexities*. New York: Basic Books, (2002).
6. Urquijo, Silvia Pongut, Stephen AR Scrivener, and Hilary K. Palmn. "The use of breakdown analysis in synchronous CSCW system design." *Proceedings of the Third European Conference on Computer-Supported Cooperative Work 1317 September 1993, Milan, Italy ECSCW93*. Springer Netherlands, 1993.
7. Bourges-Waldegg, Paula, and Stephen AR Scrivener. "Meaning, the central issue in cross-cultural HCI design." *Interacting with computers* 9.3 (1998): 287-309.
8. Kano, Nadine. *Developing international software for Windows 95 and Windows NT*. Microsoft Press, 1995.
9. Markussen, Thomas, and Peter Gall Krogh. "Mapping cultural frame shifting in interaction design with blending theory." *International Journal of Design* 2.2 (2008).
10. Rampino, Lucia. "The innovation pyramid: A categorization of the innovation phenomenon in the product-design field." *International Journal of Design* 5.1 (2011).
11. Griffith, Selena Joy, and Jens Martin Skibsted. "In pursuit of the design icon." *Proceedings of the Tsinghua International Design Management Symposium*. 2009.
12. Kovecses, Zoltan. *Language, mind, and culture: A practical introduction*. Oxford University Press, 2006.
13. Coulson, Seana. *Semantic leaps: Frame-shifting and conceptual blending in meaning construction*. Cambridge University Press, 2001.
14. Manzini, E., Susani, M., (Eds.). *The Solid Side*. VCK Publishing, Philips Corporate Design, p. 175.
15. Yair, K., Tomes, A., Press, M.: *Design through marking: Crafts knowledge as facilitator to collaborative new product development*. *Design Studies* 20(6), 495-515 (1999)
16. Lin, Rung-Tai. "Transforming Taiwan aboriginal cultural features into modern product design: A case study of a cross-cultural product design model." *International Journal of Design* 1.2 (2007).
17. Shen, Siu-Tsen, Martin Woolley, and Stephen Prior. "Towards culture-centred design." *Interacting with computers* 18.4 (2006): 820-852.

18. Tung, Fang-Wu. "Weaving with rush: Exploring craft-design collaborations in revitalizing a local craft." *International Journal of Design* 6.3 (2012).
19. Hsu, Chi-Hsien, Chih-Long Lin, and Rungtai Lin. "A study of framework and process development for cultural product design." *International Conference on Internationalization, Design and Global Development*. Springer Berlin Heidelberg, 2011.
20. Sun, Huatong. *Cross-cultural technology design: Creating culture-sensitive technology for local users*. OUP USA, 2012.
21. Gaver, Bill, Tony Dunne, and Elena Pacenti. "Design: cultural probes." *interactions* 6.1 (1999): 21-29.
22. Leong, D., Clark, H.: Culture-based knowledge towards new design thinking and practice - A dialogue. *Design Issues* 19(3), 4858 (2003)
23. Stephan, D. "An overview of intercultural research: The current state of knowledge." (2004).
24. Lee, Kun-Pyo. "Design methods for cross-cultural collaborative design project." *Proceedings of Design Research Society International Conference*. Futureground: Monash University, Melbourne Leedy. 2004.
25. Spencer-Oatey, Helen, ed. *Culturally speaking: Managing rapport through talk across cultures*. A&C Black, 2004.
26. Moalosi, Richie, Vesna Popovic, and Anne Hickling-Hudson. "Culture-orientated product design." *International journal of technology and design education* 20.2 (2010): 175-190.
27. Weinberg, Gil. "The Beatbug evolution of a musical controller." *Digital Creativity* 19.1 (2008): 3-18.
28. Weinberg, Gil. "Interconnected musical networks: Toward a theoretical framework." *Computer Music Journal* 29.2 (2005): 23-39.
29. Sheridan, Jennifer G., and Nick Bryan-Kinns. "Designing for performative tangible interaction." *International Journal of Arts and Technology* 1.3-4 (2008): 288-308.
30. Nakanishi, Yoshihito, Seiichiro Matsumura, and Chuichi Arakawa. "BOMBBeat Of Magic Box: Stand-Alone Synthesizer Using Wireless Synchronization System For Musical Session and Performance." *gesture* 5 (2014): 6.
31. Wang, Wei, Nick Bryan-Kinns, and Tie Ji. "Using community engagement to drive co-creation in rural China." (2016).
32. <https://www.arduino.cc>
33. Norman, Donald A. "Affordance, conventions, and design." *interactions* 6.3 (1999): 38-43.