

Physical Traces and Materialization of Songs for Individuals' Music Participation in Cafés: The Design and Field Studies of Camue

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Expressing and sharing an individual's music in public spaces are part of making creative culture. We designed a frame-shaped song ticket shredding speaker, called Camue, to investigate how the materialization of songs and their physical traces can facilitate music playing and sharing experiences in public spaces. Camue was deployed in two cafés for three weeks, providing music playback experience to 41 customers and 10 recruited participants. The findings showed the materialization of songs and physical traces affected users to motivate and engage their participation. The exposure of users' actions when playing songs by putting a tangible paper ticket into Camue helped users to mediate between their personal music taste while considering the public ambience of the café. Our findings imply new insights into how the co-creation of physical remnants can trigger meaningful interpretations, and what factors are needed for designing artefacts that enable better music expression of individuals in public.

Keywords: *interactive music player; data materialization; physical trace; café; field study;*

1 Introduction

Computational interventions for public spaces that encourage personal expression and communication have benefitted the creative culture for diverse groups of people (Hosio et al. 2015; Xu et al. 2019; Lindinger et al. 2013). Herein, various types of media have been used, and among them, music is perceived to be one of the most useful media for the direct or indirect representation of an individual (Kirk et al. 2016; Tidjani et al. 2016). Recently, sharing music through various types of digital tools, such as digital streaming (Cayari 2011; Liikkanen 2014), social networking (Silfverberg 2011), or instant messaging, has allowed users to express their musical preferences and interact with

others through music. In the past (the 1950s), devices with semi-automated technical services (e.g., coin-operated player piano, music box, and jukebox) for playing music that users wanted to listen to have been common in public places such as pubs. These devices have decreased or remained only in places such as a music café or in the form of a smart jukebox, as audio technology has become more portable with the emergence of cassette tapes, CDs, and LPs. Previous studies have, however, attempted to investigate the profound value of characteristics of these experiences, such as the expression of users' taste in music within a shared physical space and providing tangibility during the engagement with the devices (Gallardo and Jordà 2010; Campenhout et al. 2013). In this respect, Müller et al. (2016) have suggested the value of gaining user engagement and motivation through playing music within the physically sharing spaces. Also, the personal, tangible artefact can strengthen the value of music as an identity constructor (Kwon and Lee 2018).

In response to such issues, we found a new design space allowing users to play and share music for a public context and devise a tangible medium that can encourage user engagement through the form and interaction of the artefact (Engholm 2010). Specifically, we could see design propositions and investigations of the experiences using the designs are needed for spaces where people can create a private sphere (e.g., for small talk, meetings, or reading), enjoy music, and express a personal interest in music those spaces. Therefore, we chose a café as an exploratory context to design interactive objects for music participation experiences among various spaces. Because it is a public space in which masses of consumers visit to enjoy leisure away from home and work (Karababa and Ger 2011). The customers, specific interior design, and music (Pozos-Brewer 2015) could have the opportunity to make use of them as elements in designing experiences of expressing and sharing personal taste in music. In the aspect of deploying a new interactive artefact in the café, we considered it would be critical to consider the motif from the items that are well fit (Odom et al. 2016) in the café and selecting an item that the users can easily see without harming the atmosphere of the space.



Figure 1. Camue in situ. (Top) P9 puts her music paper ticket into Camue in Coffee Shop 1. (Bottom) Accumulated shredded traces (yellow) in Camue. Also, a song is playing, and the song ticket is shredding in Coffee Shop 2.

Based on the lessons from previous studies, we designed and developed Camue, a frame-shaped shredding speaker providing a new user experience of selecting, playing, and sharing music in cafés (Figure 1). Camue works by having users to insert a paper song ticket into the upper part of the

frame and then shredding the ticket while the music is playing. As it is purposed for use by various customers in a café, the shredded remnants on the bottom of the frame are a physical representation to visualize how many songs have been played. We deployed Camue in two local cafés for three weeks, using it to explore the experiential values with visitors and recruited participants for discovering new ways of engaging public participation, such as song selection, listening, and sharing.

2 Related Work

2.1 Sharing music through on-offline services

Previous Human-Computer Interaction (HCI) studies have suggested diverse ways to express, share, and socially interact with music through on-offline services. These studies explored the sociality of sharing, 'co-listening,' and the relationships between digitally mediated mobile music consumption. Also, they investigated self-expression by understanding how music listening information or others' reactions can be provided to individuals. More specifically, those studies proposed location-based music-sharing application and device (Burnett et al. 2012; Kirk et al. 2016), music recommendation system based on user's similar environmental context (Lee and Cho 2014), and a mobile application to discover songs currently being listened by other people in the vicinity (Seeburger 2010). For instance, there was a FamilySong that is a music sharing system for family members at a distance by applying RFID technologies with tangible boxes, cards, and web applications (Tibau et al. 2019). They argued that the system afforded both a connected feeling and pragmatic opportunities to enhance the relationship between children and their parents. This corpus of cases demonstrates that information gained from social interaction with others can allow users to discover their appropriateness and preference of music that would enrich an individual's music listening experience.

2.2 Personal expression through media in public spaces

At the same time, other studies investigated what value can be derived when physical spaces are shared between individuals to participate through not only music but also other media. The identity of a public space strongly depends on the quality of interaction and connection between collocated individuals (Monastero et al. 2018). In this, several studies have suggested various types of media participation and sharing systems. Objective Meaning is a public display that invites the audience to express themselves by exposing anonymous smartphone text messages in a library (Storteboom et al. 2017). Also, Lisa Kleinman et al. (2014) developed an application for people to create connections with others in the same physical space by posting digital content on a dual-screen laptop. Moreover, Markham and Pereira (2019) have conducted a 3-year project to investigate the experience of people donating their memory through pictures in a museum and library. These studies explore a new perspective in the design space of mediating between personal expression and public participation in an effective and mannered way in shared physical spaces. This collection of work illustrates that the expression of personal media in a shared space can contribute to improved social communication, greater empathy, and the creation of a dynamic media culture.

2.3 Music selection experiences in semi-public spaces

Specifically, existing studies proposed the design space of an interactive music playing system in a democratic manner in café or similar spaces. In this context, Jukola (O'Hara et al. 2004) was designed to provide a music selection method that allowed people to share the same public space for selecting a specific song from a pre-defined music list through voting. Also, Müller et al. (2016)

explored the design and impact of shared interactive systems, combining public display installations with a collaborative music player. Moreover, there are several attempts to let the listeners control the playback together with an application or online homepage (Ahlberg et al. 2011; Chen et al. 2012), and a visualization window (Sprague et al. 2008). Herein, digital interventions were used to democratically reflect the majority of opinions in public places. The above studies emphasized the importance of the collaborative choice of music and the reflection of common opinions. In comparison with previous studies, we focused on how users can express their personal music taste in public spaces. For this, we developed a tangible design intervention considering appearance and the interactive experience to fit with the cafe's spatial atmosphere. In this study, our work attempts to bring the above elements into the design and investigate how this artefact can naturally encourage user's participation in playing and sharing music in the café.

3 Design of the tangible music device

Cafés (coffeehouse) have customized characteristics, and music is carefully selected to create a friendly environment so that people visit one place frequently and develop emotional attachment to the café (Waxman 2006). At this point, we saw an opportunity to design a new interactive artefact that could be embedded in the space and support customers' participation in music playing. For this, we designed Camue to enable users to play their songs and see how their music is being consumed. Also, when designing the form, we considered it to be naturally blend into café's ambience both as an interior object and an interactive medium. Details of Camue is described in Figure 2.

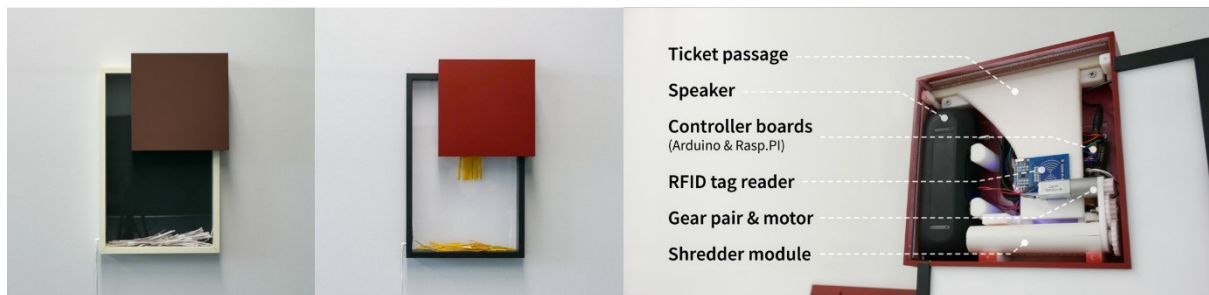


Figure 2. Details of Camue. Two colour-variated Camue prototypes are built for the field deployment study. Right photo shows the back part of Camue, and its inner structure.

3.1 Camue: a frame-shaped shredding speaker

During the design process, we explored objects placed in cafés such as vases, lighting, and frames to determine the outer shape of Camue. In the end, we decided to use the picture frame motif, where the transparent part of the frame would contain elements that can be focused on, such as pictures. In this, we were inspired by Kim et al. 's work (2019), which uses a song ticket shredding method to play music. It is a familiar method for irreversibly destroying paper materials and physically visualizing their remains. Through this, we considered that new visitors would easily understand that music is being consumed in the space. When a user inserts a ticket, Camue shreds it in an amount of time similar to the length of the song, to indicate that the song is playing. Shredded tickets pile up inside the Camue, representing the consumption of music that has been played in the café for other customers to see.

3.1.1 Paper Song Ticket

Instead of using pre-created tickets that contain the specific song's information, we chose a way that allows users to create their own ticket by directly writing down the song information onto the ticket. This was done to remove the restriction on selecting a song only for the tickets that have been already created. To realize this method, we attached a sticker-type RFID tag in the front of the ticket and added simple usage instructions with pictures and text on the backside (Figure 3). After the song information is written by users on the paper ticket, a YouTube URL of the song is mapped manually with the unique ID of RFID tag. In doing this, the song library that contains the data of the 'ID-URL' can be automatically stored in the Camue's controller board via Wi-Fi in real time. An RFID reader in the Camue recognizes the ID, and the speaker plays the song of the URL.

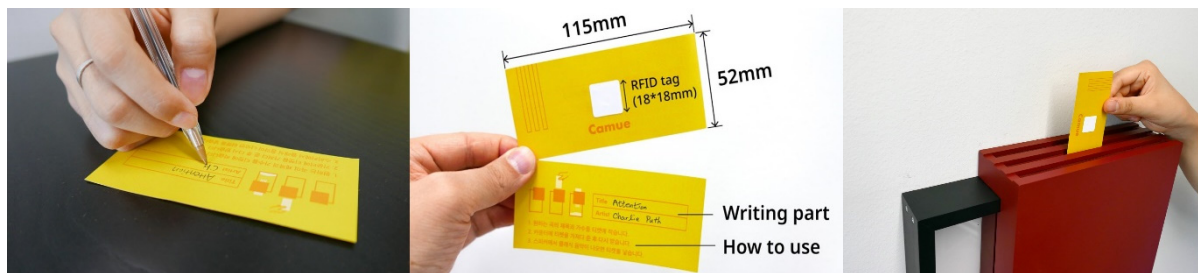


Figure 3. Writing down song information (left), details of the paper ticket (centre) and inserting it into Camue (right).

4 Field Study

We conducted a series of field studies with Camue to investigate the value of user experience with playing music (song selection, listening, and sharing) in cafés.

4.1 Participants

Weekly visiting participants: We recruited 10 participants (ages 20s and 50s, six females and four males, P1 to P10) who will use Camue periodically (once a week) for 3 weeks. This was because we wanted to investigate how the experience of using Camue changes over time during the users' weekly engagement with the device in the cafe. Among them, five were recruited at Café 1, and the other five were at Café 2. Participants visited each café once a week, which totaled three times per participant during the three weeks. We asked them to stay in the café for one hour, sit at one table, and make notes about the experience of the participation of their own and other visitors through using Camue. An interview followed for about 20 minutes per session.

Customers of the café: We also wanted to see the experience of customers who visited the cafés and hear about how they are motivated and their thinking when they insert the ticket and when they listen to others' songs. The total number of people (in two cafés) who took and wrote on tickets during the three weeks was 48 (Week 1: 9, Week 2: 19, Week 3: 20). Among them, 41 people put their tickets in Camue, and seven did not. Their age groups varied from teens to 70s. The majority of customers were in 20s (19), 50s (9), 30s (8), and 40s (6). Among them, 20 were interviewed for about 10 minutes, and we classified them as O1 to O20. We also interviewed the two owners once a week for about 30 minutes. Details of the interviews are summarized in Table 1.

Table 1. Summary of interview questions

Week	Subject type	Interview content
Week 1	Recruited participants and customers	<ul style="list-style-type: none"> - First impression of Camue - External factors in song selection - Feedback on overall experience
Week 2 and 3		<ul style="list-style-type: none"> - Changes in consideration of song selection & thinking about space - About song changes by others - Advantages/disadvantages of playing music with Camue
Week 1	Owner of Café	<ul style="list-style-type: none"> - Applying song request service in the café - Customer reactions to Camue - About music played by guests
Week 2 and 3		<ul style="list-style-type: none"> - Changes over three weeks - The most memorable situation - Their desire to keep using Camue - Improvements for commercialization

4.2 Deployment of Camue in Two Local Cafés

Café 1 (Figure 1b) is run by Marry, a woman in her 30s. It has a cosy wooden interior, about 115m² in size, and is adjacent to residential areas and shopping centres - visitors' range in age from the 20s to 40s. Camue was installed on a table in front of the counter, where visitors order coffee. Marry prefers to play calm music (e.g., indie music, ballads) and cares a lot about playing music that fits the mood of the cafe. Sometimes, she changes the music in real-time according to the age and time of visitors.

Café 2 (Figure 1d) is run by Alice, a woman in her 50s. It is in a free-standing two-story building on a rural village road, about 165 m² in size. There are many patrons and visitors' range in age from the 20s to 70s. Camue was installed next to the counter, making it more noticeable to visitors. Alice usually searches the café's music recommendation charts and plays songs for 2–3 hours in a row.

As the café is a commercial space, it was not easy to rent the space full-time. We could choose specific deployment hours on alternating days for each café, and we conducted our study on Tuesday, Thursday, and Saturday from 2-4 p.m. in Café 1 and on Monday, Wednesday, and Friday from 12-2 p.m. in Café 2, which totaled 18 days (two hours per day) of deployment during the three weeks. We selected those times to conduct our study because those periods were not too crowded in each café. Researchers installed Camue near the counter in a location readily visible to visitors and owners. We placed information cards on the tables. An A4-sized banner, which informed visitors of Camue's services, and two small boxes were deployed next to the counter. One box contained blank tickets with nothing written on them, and the other box allowed users to put in their ticket after they write the song information. To hold the Camue, we used an easel that matched the frame-shaped device.

4.2.1 Scenario of How Camue was Operated in Cafés

First, a user takes one blank ticket from a box and writes the title and artist of the song s/he wants to listen (Figure 4-2). The user puts the ticket into another box, then a researcher finds the song's

YouTube URL, matches it to the RFID tag, and gives it back to the user. This process has to be done manually by us during the field study. When the songs are matched to each playlist urls, participants could insert the ticket into the Camue at the time s/he wants (Figure 4-4). After that, Camue shreds the paper ticket and plays the song at the same time. Camue's transparent acrylic part allows the user to watch the ticket-shredding process. Another song cannot be played until the previous user's song has completely ended. Then the default music, café owner's selection, will be played if no ticket is inserted.

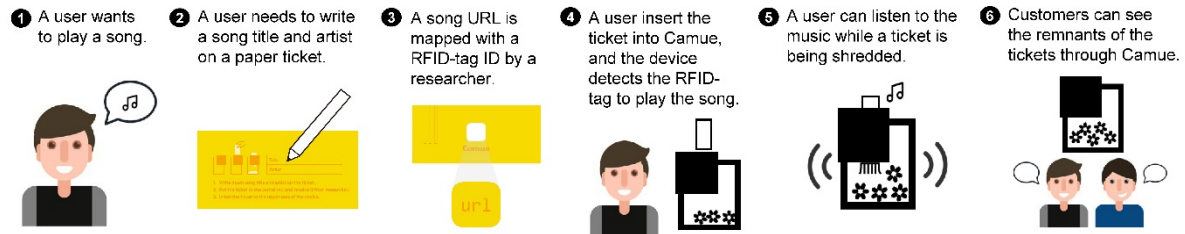


Figure 5. Scenario of how Camue was operated in the café.

4.2.2 Researchers' Roles in the Café

Three researchers shared their roles, one served as a tech staff, and the other two conducted user interviews. The tech staff sat at a table near the counter with a ticket box to see which users had entered which tickets. After the user put a ticket into the box, the tech staff gets the ticket and matched the song URL to the RFID tag of the ticket and gave it back to the user. The researchers resided at one of the empty tables and ordered coffee to be more natural in the café and customers were not asked to participate in the experiment by the researchers or owners.

4.3 Data Collection and Analysis

We transcribed all interview recordings from recruited participants, café owners and customers who used Camue. Based on the interview data, three co-authors generated open codes of answers and comments after the field study. By using those codes, we analysed the data by affinity-diagramming and went through an iterative process of grouping. During this process, we created thematic connection of the open codes, resulting in three large clusters as follows: 1) influence of physical traces of music consumption, 2) expressing one's taste of music in café through playing songs using Camue, 3) and interaction experience of selecting-playing-sharing their songs through Camue. Afterwards, we added two researchers to extract meaningful sub-themes and related statements by reviewing open codes in each cluster. From this, we detailed how the physical traces and interaction experiences of Camue supported participants' musical experience in café.

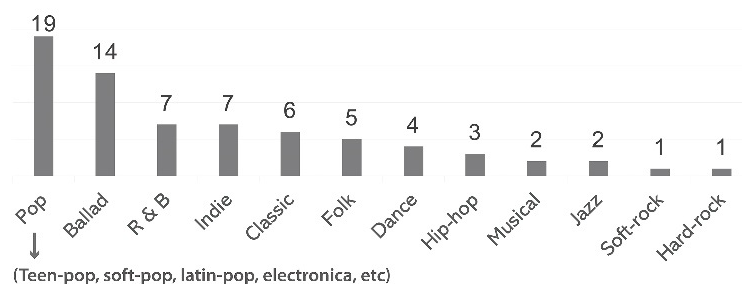


Figure 5. The number of songs per genre played by the users.

5 Findings

During the three weeks, 73 song tickets were inserted into Camue. Of them, 71 different songs were played (for song genres, see Figure 5). Ten recruited participants used one ticket per week (total of 29 tickets), and 41 customers used 41 tickets. Among them, three participants asked for more tickets, and we offered one more to each participant. Those log data were utilized to check the usage of Camue and interpret the behaviours of participants or customers in relation to their interview data.

5.1 Roles of Materialization and Physical Traces of Music

We identified that the destructiveness of a physical medium (the paper ticket) through the shredding process helped users to recognize the consumption of music. P7 stated, *"If it [the ticket] just dropped, it would give me the feeling of being discarded and threw away, but I think it's being consumed because the ticket was shredded. I like the way [of shredding the ticket] as it provides the impression that the song is now playing and shows a visualization of the progress."* More specifically, O9 remarked that the shredding process had facilitated his engagement with the device by inserting a physical ticket to play the music. *"I think the shredding mechanism is creative and unique; it seems like the ticket fulfilled its mission, feeling exactly it 'was used.' I don't think there will be much impact if this one [the ticket] remains as it is or just passing through the device."*

Alice (Café 2 owner) stated that the uniqueness part of Camue is the visualization of the progress of shredding during music playback: *"I think the visual effect [of Camue] is one of the biggest parts compared to other music-playing machines. The appearance of slowly shredding the progress of the ticket until the end of the music is a new stimulus for people. Thus, customers might like it."* In this regard, P8 mentioned the emotional stimulus provided by watching the ticket shredding process: *"It was a visual effect that stimulated my emotions. Just like an old cassette tape player, which provokes me a sense of retro music playing experience, I could see how far it has progressed."*

Also, we identified that the frame shape of Camue makes customers focus on and wonder about the shredded traces of the ticket inside the transparent part of the device. O7 remarked, *"I thought that the owner was decorating the café with shredded receipts."* The physical visualization of music ticket consumption aroused users' interest in the songs chosen by others who previously used the device. O19 mentioned, *"Just before when I went to put the ticket, I was looking inside [of Camue] who had inserted what. I wondered about what kinds of songs that people have requested."* Six of the recruited participants noted that the traces of tickets affected the users' motivation toward their participation. P5 stated, *"As the device [Camue] continuously shows the accumulation [of the shredded traces], it may get more attention from other people. I think if more people do that [insert song tickets]; the participation rate is more likely to increase. I would also like to participate because the amounts of traces prove how much music was played."*

The interview results showed that the expression of the user's taste in music by putting a paper ticket into Camue enabled to the user to leave traces of experiences. Notably, it showed the intangible footprints of the user's experience regarding their music participation.

5.2 Personal Taste in Music and Public Ambience of Café

Previous music-playing systems in public, such as a jukebox, used a list of songs set by the owner. However, customers in the café were able to select the songs that they wanted through Camue. These characteristic allowed customers to play music freely according to their own decision. Because

of the unrestricted way of selecting music, at the start of the field study, Marry worried that the music would not match the mood of her café and wondered whether she should place a restriction on the genre of music. She noted, *"The customer may play a song because he liked it, but it is difficult to tell him/her, 'this song is not allowed'. I have to open my café anyway and think about whether the song may suit this mood, and some songs need to be sanctioned."*

Contrary to the owner's concern, most participants noted that they chose a well-known piece of music or music that everyone would like it, considering the mood of the café and the exposure of their actions to put the ticket. In other words, the human sensor (e.g., other customers' presence) during the interaction process with Camue allowed for filtering of unethical songs for the public. During the three-week study, various genres of music were selected (Figure 5), the most common of which were pop and ballad, and some of the participants selected songs of unique genres (e.g., hard rock). For instance, P5 usually played soft-pop or classical music. He mentioned the influence of people while his song selection: *"There are some people who are studying, talking and, working, so I thought it would be good to play a song that fits the mood or can make the mood lively; something like, not too loud."*

As shown in a previous study, people in a common space seemed to accept some actions if the known risks are low (Waern 2016). We saw that customers generally tried to tolerate the music played by Camue in the café. People mentioned the situation where they listened to a song selected by various people through Camue: *"Actually, most people haven't played uncomfortable music" (O13); "It's inevitable because it's the place where a lot of people are together" (O18); "I have opportunity to select a song that I want, so I should respect other people's rights" (P4); and "It is an good opportunity to experience various genres of music rather than listening to the music of the store owner's personal taste" (P5).* As the song was played immediately at the time the ticket was inserted, the ticket-inserting process was shown and received attention from others. This aspect seemed to influence people to be more carefully conscious of others in their music sharing experience. Several participants noted that getting others' responses about putting a song ticket affected their song selection.

By putting their own ticket, users could involve in creating lasting traces of their participation and contribute to forming the atmosphere of the café. This served as an opportunity to expand the areas that can be controlled by individuals in the café, a public space. Through this, the above interaction may support users to strengthen the emotional bond with the product and space (Lee et al. 2016) and make thoughts to the café. At the same time, in line with previous studies (Lampe et al. 2010; Storteboom et al. 2017), the exposure of personal expression in a public space gives motivation and responsibility for participation to the subject contributing to public content.

6 Discussion and Design implications

6.1 Co-creation of Physical Traces in Public

Current song selection methods through mobile applications and physical devices, such as Touchtunes and Virtuo (2020), offer users the ability choose and play music freely in bars or pubs. Compared to those services, Camue's interaction differs in that it allows users to physically take their music ticket, shred it to play the song, and see the remaining physical traces of music from others in the space. In this regard, designing for actively engaging interaction through the physicalization of

data has been an ongoing area of interest in the HCI community. Recent studies have revealed that everyday interaction with physicalized personal data might motivate natural behaviour change through self-reflection (Ju et al. 2019; Thudt et al. 2018).

The traces visualized the invisible, abstract experience of playing and sharing music, allowing users to perceive 'how long a song has been played' by showing a paper ticket being shredded as well as the song being played through the transparent part of Camue. Moreover, the accumulated traces demonstrated 'how many people participated' through the volume of remnants; it also gave visual evidence that implied 'how the musical mood of a particular space had been formed.' In other words, remnants of tickets were able to express the quantity and kind of the music consumed and shared in a specific space. While space, in our case café, has been mostly interpreted by the café owners as commercial space. In our study, the café customers had the opportunity to reinterpret the space more actively by participating in changing the mood of the space by playing the music that they want. This abstract representation of the space through using physical traces can serve as a social patina that raises participants' curiosity and helps them to get the attention of others, even those who don't know about the meaning of the traces (Lee et al. 2015). From what we mentioned in the findings, this opportunity introduced a new way of adding value to the space by allowing the users to rethink their previous image of the café. Furthermore, previous studies (Barthel et al. 2013, Fedosov et al. 2018) have remarked that the history of use accompanied by shared resources offers expressive and rich mementos for users. In our case, we identified that the shredded traces left from people's use could be applied not only to the personal artefact but also to the interactive artefact in a shared public space. This could provide an opportunity to associate with the thoughts of others' experiences of music playing, such as songs, subjects, or the amount of consumed music in the space.



Figure 6. Various colours of shredded tickets indicating the genre of the music.

In addition, because a café is a space that consists of individuals or small groups who create private spheres, the space's atmosphere may limit the range of musical genres that will be played. Accordingly, there is a need for a design that mediates between participation of playing and sharing music with contemplation of song selections and expressing participants' song tastes in public spaces. The exposure of user's action through the physical interaction process affects users' consideration of the ethics of song selection, but the unified visual (e.g., genre, artist) of the remnants of the shredded tickets (Figure 6) may add new value to publicly created music. In other words, co-creation of remnants made by the public can give the user a better understanding of the space and further allow the space to be characterized as a space for sharing specific music.

6.2 Designing for Self-expression in Public Spaces

Based on Camue's design considerations and our findings from the study, we propose the following factors in designing products that enable personal expression in public places.

The first factors are (1) the form, in terms of styling design of an object, might need to be inspired by everyday tools (e.g., frames) so that a designer can incorporate its characteristics or unique aspects into the designed object, and (2) the application of embodied knowledge and actions (e.g., writing on paper) that one can use to design interaction with everyday tools for providing an intuitive interaction to the users. This suggests that designers could leverage various knowledge and behaviours that are experienced and learned with everyday objects. By doing so, designers can evoke curiosity and excitement and provide better engagement with the designed object so that they can lead the users to interact with the object in a more desirable way, as it is meant to be experienced. This approach can also lower the technical or cultural barriers for users to experience the new interactive device, especially in a public space, where there is more chance for users to be embarrassed or to get lost in the interaction loop than in a private space. In addition, as Gaver et al. (2004) suggested, there is a possibility that the user experience of the digital interface with non-digital actions may provide a playful experience. This is particularly important in designing an interaction loop because it generates the honeypot effect as successful engagement and 'seemingly' playful experience can motivate other people in the same space to start interacting with the object (Zajonc 1965).

The second factor is applying physical irreversibility to the medium (Pierce and Paulos 2015) for the restriction of public participation. The use of paper material, such as a song ticket in our study, as a medium of participation, is meaningful for physically representing the action of participation in the public space. Irreversibly destroying the tangible material (a paper ticket, in our case) allowed the user to perceive the consumption of their personal involvement in public spaces. Thus, it is possible to induce responsible, ethical, and considerate decision-making when selecting and sharing music in a public space with strangers. We found a study that argued for ephemeral consumption of physical music, and contents allowed careful selection of music (Kim et al. 2019). This temporary way of using media could naturally raise barriers to one's repeated and indiscriminate use of a product. Especially to the product that can inflict a negative experience on others in public spaces. The above approach may increase the value of music participation in public and the focus on the users' experience.

6.3 Designing for Indirect Restriction of Participation

In spaces like cafés, privately owned public spaces, the owner's rules come first, and he or she has the right to enforce the rules (Pozos-Brewer 2015). The participation through Camue supported the building of co-created song ticket traces. There is a need for a way to understand each owner and customer, which should not lean toward one's needs over those of the other. That is, rather than direct restrictions of music by the owner, the colour of traces can indirectly deliver a genre restriction for song selection (e.g., blue tickets only for jazz). Furthermore, we expect that a certain mood or vibe for the music that fits the space would be formed over time, and that could be visualized through the shredded traces. In this, those physical traces may illustrate the most played music genre of the space through patterns or a percentage of colours. Furthermore, the traces could provide implicit messages as a social signifier (Norman 2013), evoking new interpretations of the behaviour of others in the space for users who first faced the artefact for music participation.

7 Limitation and Future Work

In Camue's interaction loop, there was a process in which a researcher mapped the RFID tag of the ticket with a URL link of the song. This was because we wanted to allow users to hand-write the song title and singer onto the paper ticket themselves to select a song for the cafe. However, it (mapping

URLs to songs) had some limitations due to the adding of a semi-manual process during the user-device interaction. The intervention also created positive social interactions, such as creating new communication between customers and the owner and the owner's inclusion of customers' music in the café's song playlist. The automatic process, such as technical implementation, regarding the recognition of the hand-written information may support the independent use of Camue in real-life situations. At the same time, we also found that it is essential to adjust the tension of the automatic and manual process for personal expression through media in commercial spaces. The careful balancing of both manual and automatic processes in designing interactive public tangible objects could encourage the customers' ethical participation and the owner's openness in accepting the publicly approachable device for their space's mood change.

8 Conclusion

We designed Camue to reinterpret existing but decreasing partially automated music-playing devices (e.g., jukebox) as a new, interactive, tangible artefact for supporting users to express their music taste in public spaces. During the design process, we significantly considered how the design could be blended into the atmosphere of cafés enriching the way that people interact with the artefact to share their personal music preference with others. To investigate the experiential value of music during using Camue - song selection, playing, and listening - we deployed Camue in two local cafés for three weeks. Within the period, we could see 41 customers engaged in using Camue and hear the weekly experience of 10 recruited participants. Findings showed that the tangible interaction of using a paper ticket and the physical traces of song tickets motivated users to engage with Camue and to visually recognize the consumption of music. Our findings imply how the messages of physical traces can be used to evoke a new interpretation of the behaviour of others in the public space.

Acknowledgments. This work was supported by NRF-2020R1F1A1054047 through the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT (MSIT).

References

- Ahlberg, J., Andrén, A., & Zettersten, T. Blicko social music places. *In Proc. Mobile HCI'11*, 683-687.
- Barthel, Ralph, et al. An internet of old things as an augmented memory system. *Personal and ubiquitous computing* 17.2 (2013): 321-333.
- Burnett, D., Lochrie, M., & Coulton, P., "CheckinDJ" using check-ins to crowdsource music preferences. *In Proc. Academic MindTrek'12*, 51-54.
- Chen, Z., Yavuz, E. A., & Karlsson, G., What a juke! A collaborative music sharing system. *In IEEE WoWMoM'12*, 1-6.
- Christopher, C. The YouTube Effect: How YouTube Has Provided New Ways to Consume, Create, and Share Music. *International Journal of Education & the Arts*, 12, 6 (2011), n6.
- Engholm, I. (2010). The good enough revolution—the role of aesthetics in user experiences with digital artefacts. *Digital Creativity*, 21(3), 141-154.
- Fedosov, A., Odom, W., Langheinrich, M. and Wakkary, R., Roaming Objects: Encoding Digital Histories of Use into Shared Objects and Tools. *In Proc. DIS'18*, 1141-1153.
- Gallardo, D., & Jordà, S., Tangible jukebox: back to palpable music. *In Proc. TEI'10*, 199-202.
- Gaver, William W., et al. "The drift table: designing for ludic engagement." *CHI EA'04*.
- Hosio, Simo, et al. "Life through the lens: a qualitative investigation of human behaviour with an urban photography service." *In Proc. BCS HCI'15*.

- Ju, S., Lee, K. R., Kim, S., & Park, Y. W. Bookly: An Interactive Everyday Artifact Showing the Time of Physically Accumulated Reading Activity. *In Proc. CHI'19*, 1-8.
- Karababa, E., & Ger, G. (2011). Early modern Ottoman coffeehouse culture and the formation of the consumer subject. *Journal of Consumer Research*, 37(5), 737-760.
- Kim, K., Jang, S., Kim, B., Kwon, H., Park, Y-W. muRedder: Shredding Speaker for Ephemeral Musical Experience. *In Proc. DIS'19*, 127–134.
- Kirk, D. S., Durrant, A., Wood, G., Leong, T. W., & Wright, P., Understanding the sociality of experience in mobile music listening with Pocketsong. *In Proc. DIS'16*, 50-61.
- Kleinman, L., Carney, A., & Ma, A. Billboard: interacting with personal public displays. *In CHI EA'14*, 495-498.
- Kwon, D., & Lee, W, Artifact Mixtape: Curating Music in Personal Tangible Artifacts. *In Proc. DIS'18*, 265-270.
- Lampe, C., Wash, R., Velasquez, A., & Ozkaya, E., 2010. Motivations to participate in online communities. *In Proc. CHI'10*, 1927-1936.
- Lee, M., & Cho, J. D., Logmusic: context-based social music recommendation service on mobile device. *In Proc. UbiComp'14*, 95-98.
- Lee, M. H., Cha, S., & Nam, T. J., Patina engraver: Visualizing activity logs as patina in fashionable trackers. *In Proc. CHI'15*, 1173-1182.
- Lee, M. H., Son, O., & Nam, T. J., Patina-inspired personalization: personalizing products with traces of daily use. *In Proc. DIS'16*, 251-263.
- Liikkanen, L. A., Music interaction trends in Finland: YouTube and Spotify. *In Proc. Academic MindTrek'14*, 127–131.
- Lindinger, C., Mara, M., Obermaier, K., Aigner, R., Haring, R., & Pauser, V. 2013. The (St) Age of Participation: audience involvement in interactive performances. *Digital Creativity*, 24(2), 119-129.
- Markham, A. N., & Pereira, G. 2019. Analyzing public interventions through the lens of experimentalism: the case of the Museum of Random Memory. *Digital Creativity*, 30(4), 235-256.
- Monastero, B., Lucero, A., Takala, T., Olsson, T., Jacucci, G., & Mitchell, R., Multimedia Ubiquitous Technology for Opportunistic Social Interactions. *In Proc. MUM'18*, 545-550.
- Müller, M., Otero, N., & Milrad, M., Shared Interactive Music Experiences in Public Spaces: User Engagement and Motivations. *In Proc. ISS'16*, 287–296.
- Norman, D. 2013. The design of everyday things: Revised and expanded edition. Basic books.
- Odom, W., Wakkary, R., Lim, Y. K., Desjardins, A., Hengeveld, B., & Banks, R., From research prototype to research product. *In Proc. CHI'16*, 2549–2561.
- O'Hara, K., Lipson, M., Jansen, M., Unger, A., Jeffries, H., & Macer, P., Jukola: democratic music choice in a public space. *In Proc. DIS'04*, 145–154.
- Pierce, J., & Paulos, E.. Making Multiple Uses of the Obscura 1C Digital Camera: Reflecting on the Design, Production, Packaging and Distribution of a Counterfunctional Device. *In Proc. CHI '15*, 2103-2112.
- Pozos-Brewer, R., Coffee Shops: Exploring Urban Sociability and Social Class in the Intersection of Public Private Space. (2015).
- Seeburger, J., Foth, M., & Tjondronegoro, D., Capital music: personal expression with a public display of song choice. *In Proc. NordiCHI'10*, 777–780.
- Silfverberg, S., Liikkanen, L. A., & Lampinen, A., I'll press play, but I won't listen: profile work in a music-focused social network service. *In Proc. CSCW'11*, 207–216.
- Sprague, D., Wu, F., & Tory, M., Music selection using the PartyVote democratic jukebox. *In Proc. AVI'08*, 433–436.
- Storteboom, S., Thudt, A., Knudsen, S., & Carpendale, S., Objective Meaning: Presentation Mediation in an Interactive Installation. *In Proc. ISS'17*, 360–365.
- Thudt, A., Hinrichs, U., Huron, S., & Carpendale, S., Self-reflection and personal physicalization construction. *In Proc. CHI'18*, 154.

Tibau, J., Stewart, M., Harrison, S., & Tatar, D., FamilySong: Designing to Enable Music for Connection and Culture in Internationally Distributed Families. *In Proc. DIS'19*, 785–798.

Tidjani, A., Cho, E., & Lee, P., MuSme: A tangible skin suit for music creation. *In Proc. TEI'16*, 743–748.

Touchtunes. The #1 jukebox mobile app. Retrieved from <https://www.touchtunes.com/>

Van Campenhout, Lukas, et al. "Physical interaction in a dematerialized world." *International journal of design.-Taipei*, currens 7.1 (2013): 1-18.

Virtuo: The world's first smart jukebox. Retrieved from <https://www.touchtunes.com/products/virtuo/>

Waern, A., The ethics of unaware participation in public interventions. *In Proc. CHI'16*, 803–814.

Waxman, L., The coffee shop: Social and physical factors influencing place attachment. *Journal of Interior Design* 31, 3 (2006), 35–53.

Xu, D., Zonda, I., Jongeling, M., & Huisman, G., Learning from Public Toilet Doors: Designing a Participatory Feedback Platform for a Connected Campus. *In CHI EA'19*, 1-6.

Zajonc, R. B. Social Facilitation. *Science* 149, 3681 (1965), 269-274.