

Possibility of Utilizing Digital Traces for Enhancing Emotional Values of Digital Artifacts

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Abstract

Background In the field of art, artists and designers often deliberately utilize material traces, called patinas, as a design resource for increasing the emotional value of an object regarding its aesthetic appearance, historicity, and authenticity. Meanwhile, besides analog objects, we encounter and possess several digital artifacts that generate digital traces. Then, can designers borrow the concept of patinas and utilize digital traces for enhancing the emotional value of digital artifacts?

Methods We conducted guided tours and semi-structured interviews with 22 participants at their homes. We gathered the participants' stories with their analog artifacts, digital devices and digital contents to explore the emotional impacts of traces on the possessions.

Results We analyzed how and what kinds of traces are generated in the artifacts and compared the emotional impacts of material traces and digital traces on the artifacts. The impacts were classified into aesthetic appearance, historicity, and authenticity. As a result of the comparison, we discussed design opportunities that should be considered for designing digital artifacts that improve with digital traces.

Conclusions As an early attempt to explore issues of making emotionally valuable digital artifacts via digital traces, this research investigated what kinds of material and digital traces are constructed and how the traces affect emotional value. This paper makes a contribution by exploring ways of using digital traces as a design resource in the digital domain.

Keywords Patina, Material Trace, Digital Trace, Emotional Value, Guided Tour

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1. Introduction

In the field of art, there has been a technique for deploying material traces, called patinas (Krumbein, 2003; DeSilvey, 2006). A patina is understood as the material traces left by the passage of time on the exterior surfaces of physical objects. It is known that artists and designers often deliberately utilize patinas as a design resource for increasing emotional values of an object regarding aesthetic appearance, historicity, authenticity and uniqueness (Hiiop, 1998; Rosenstein, 1987). The aesthetic value is related to how it improves the visual and tactual quality of objects. The historic value is related to how traces denotes the object's historicity and stimulates the reflective response to its antiqueness. The authentic value is related to the uniqueness of an artifact. In common, material traces in an object has been considered as a useful design resource that improve emotional values of an object. For example, in case of Gold Wedding Ring by Torafu Architects (2012; Figure 1.a), thin exterior coat of silver plating is rubbed away to reveal a gold band underneath. The ring band actively portrays the time shared between two people as the individuals wearing the set displays this passage of time through the patina. Another example, Broken White, explores processes of time-based transformation by cracking (Heijdens, 2004; Figure 1.b). The smooth plates, cups and bowls develop tiny cracks that slowly reveal intricate floral patterns as they facilitate the consumption of food over years.

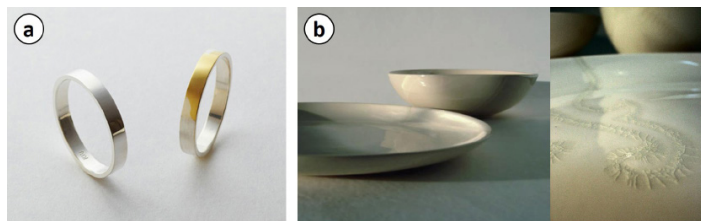


Figure 1 Patination by using material traces: (a) Gold wedding ring (Torafu Architects, 2012), (b) Broken White (Heijdens, 2004)

Meanwhile, besides analog objects, we encounter and possess several digital artifacts; digital devices and digital content (Table 1). Digital devices like a mobile phone contain circuits to operate using digital signals. They have a physical form like an analog artifact and are able to receive, store or send digital signals. Digital content is a media stored as digital data such as a digital photo, a movie file etc. Recently, digital content is frequently used within a software system without previous physical forms like CD or tapes.

Due to the nature of digital artifacts, from the perspective of traces, while analog artifacts only gathers material traces, both digital device and content can generate digital traces which are also known as digital footprints. However, in digital domains, the concept of patinas has been metaphorically applied in the graphical user interfaces for pragmatic purposes (Hill et al., 1992). Then, how can designers apply the concept of patinas and utilize digital traces for enhancing emotional values of digital artifacts? Will people consider digital artifacts with digital traces emotionally valuable?

Table 1 Comparison among analog object, digital devices, and digital content

	Form	Possibility of Digital Processing	Examples
Analog Artifact	Physical Form	None	Cookware, musical instrument etc.
Digital Device	Physical Form	Able to receive, store, or send digital info.	Mobile phone, laptop, mp3 player
Digital Content	Hybrid Form (Accessible inside Digital Devices)	Any type of content that exists in the form of digital data	Music file, digital photo, movie file

In this paper, we are specifically concerned with the ways in which digital artifacts including digital devices and digital contents are perceived to improve rather than deteriorate with age—ultimately as a means to engender more enduring human-artifact relationships. By borrowing the perspective of patinas in art area, we explored the possibility of designing with digital traces, which enables enriching emotional values of designed digital artifact in the long term. As a research method, we conducted interviews and gathered general people’s stories with their possessions relevant to the impacts of traces. From the process, we compared impacts of material and digital traces in analog artifacts, digital devices, and digital contents and finally discussed design implications for making digital artifacts that improve with digital traces.

2. Method

2. 1. Participants & Study Process

We recruited 22 participants (12 males and 10 females including 4 couples) using online advertisements. The participants came from a variety of backgrounds and occupations (e.g., patent lawyer, programmer, translator, housewife, designer). Our participants were limited to age from 20 to 35.

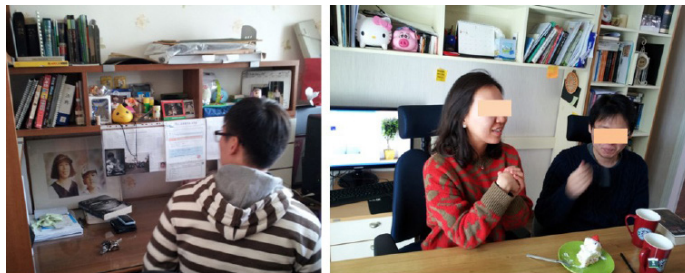


Figure 2 Guided tour and interview

The reason for the constraint was because (i) they are in early adulthood and engaged in a process heavily associated with the consumption of analog and digital artifacts (Erikson, 1994). Additionally, (ii) this group of people has experienced the rise of digital technologies and services over their lifetimes. Unlike other age groups, we expected that the participant group with this background could provide insights associated with traces of analog and digital artifacts.

As a research method, we chose a guided tour and a semi-structured interview (Figure 2) (Kirk & Sellen, 2010). Since we assumed that everyone might have artifacts with values that have increased in relationship to traces in his or her house, we arranged for each participant to give us a guided tour of his or her home. We first asked the participants to show any artifacts in their house that they have considered precious and they have used for a long time from the past. To investigate diverse cases of traces among not only analog artifacts but also digital artifacts, we asked participants to give us a tour of their digital artifacts such as digital devices and digital content files kept in digital environments (e.g., PC, mobile phone, web account).

After the tour, we continued with semi-structured interviews aimed at developing understanding of details of traces in each analog artifact, digital device and digital content. Participants spontaneously chose one to three artifacts in each artifact type and offered accounts of what the artifacts were, telling their stories and associations with traces. They were asked to give more detail about (i) how and what kinds of traces are generated in the artifacts, and (ii) what the impacts of traces were regarding the values of the artifacts. In case of digital devices, we asked about both material traces and digital traces. The interview lasted an hour.

2. 2. Analysis

In all study sessions, an audio record was kept of all conversations; this along with the photo record of items in homes was used as the primary source of evidence in the analysis. From the interview data and the photo record, we were able to classify types of traces and their impacts for improving certain values of artifacts. In total, we could gather 125 stories with traces (Table 2); 76 stories about analog artifacts, 23 stories about digital devices, 26 stories about digital content.

Table 2 Type of collected items

	Number of Stories	Examples of Collected Items
Analog Artifact	76	Cooking utensils (coffee), musical instruments (guitar, violin), sport instruments (baseball glove, soccer shoes), furniture, books, beddings, clothes
Digital Device	23	Laptop, iPod, digital camera, game console, TV, mobile phone, music player
Digital Content	26	Digital photo, movie file, social media account, music album, e-book file, game character, user-created content file

The interview data were iteratively analyzed more than three times in total with an interval of at least two days of spare time in-between the analysis sessions for enhancing validity. Our research team with 3 designer researchers analyzed the transcribed data using three previously identified categories about emotional values of patina as codes—*aesthetic*, *historic*, *authentic*. We employed an inductive open coding process to classify relevant items into emerging categories when they did not fit into one of three categories. Finally, we added a functional value as a new category to extend the existing categories. We refer to each participant by her or his gender and participant number. For example, F1 stands for female 1. CM2 stands for male (husband) of couple 2.

3. Findings

In the following, we explain what kind of material and digital traces exist in analog and digital artifacts and how differently they affect artifacts' emotional values with several examples taken from field observations (Table 3). Overall, the impacts of material traces on analog artifacts were similar to the patinas of old artworks. About the digital devices, participants mentioned that the material traces hampered their original aesthetic appearances or rarely affected historic and authentic values. About the digital devices and digital contents, we could observe that digital traces were frequently used to provide convenience to users.

Table 3 Impacts of traces on emotional and functional values

	Emotional Impact			Functional Impact
	Aesthetic Appearance	Historicity	Authenticity	
Analog Artifact	(-) Material traces degrade original appearances.	-	-	(-) Material traces cause breakdown.
	(+) Material traces mature by improving visual & tactile aesthetics. (ex. leather wallet, wooden table)	(+) Material traces help owners recall pasts. (ex. baseball glove, book)	(+) Objects become distinctive visually. (ex. leather wallet)	(+) Material traces make comfortable fit & give information (ex. soccer shoes, book)
Digital Device	(-) Material traces degrade original appearances. (ex. scratches in CD players)	-	(-) Users want to personalize device physically. (ex. mobile phone covers)	(-) Material traces cause breakdown. (ex. physical buttons and display)
	-	(+) Digital traces remind users of past experiences & achievements. (ex. running app, music list in mobile phones)	-	(+) Digital traces are used for efficiency & information. (ex. call log in mobile phones)
Digital Content	-	(-) Digital traces of digital content are not archived for users' history. (ex. e-book file VS physical book)	-	-
	-	-	(+) Personal digital traces can be added. (ex. comment's in PDF, photo files)	(+) Digital traces are used for efficiency & information. (ex. recent music list)

(-) Negative Impact / (+) Positive Impact

3. 1. Traces of Analog Artifacts

3. 1. 1. Examples of Traces of Analog Artifacts



Figure 3 Examples of physical artifacts (M5's soccer shoes and tennis racket, M8's book)

The participants mentioned their analog artifacts such as cooking utensils, musical instruments, sport instruments, furniture, books, beddings, clothes, and a wallet (Figure 3). Most traces of analog artifacts were similar to the patinas of old artworks. Fading color, scratches, abrasions, and smells correspond to traces of the analog artifacts. These kinds of material traces were usually generated in the process of using the artifact and its being touched by users and environment. For instance, CM1 described the trace of his six-year-old wallet. Although he got a new wallet a few months ago, he preferred the old one due to its textural quality, which become softer than when he bought it.

Unlike the naturally accumulated material traces, participants mentioned that they sometimes left traces with intention. M8's books that he had read while he was at university illustrate the trace. The books contained trace in the form of scratches on the cover, tears on the pages, and the smell. Besides the naturally made traces, the books had dog-eared pages and written memos. Dog-eared pages were intentionally created markers placed in the books so he could return to certain page in the future. In this way, participants could leave an informative trace on the artifacts for recording the procedure of user experience or storing useful information.

3. 1. 2. Impacts of Traces on Analog Artifacts

About Aesthetic Value: Material traces could make an object more aesthetic in visual and tactile ways. For example, CM1 mentioned that his leather wallet has become softer, thus he said he consider his old wallet more precious. There were several objects made of natural materials, such as wood, that through the process of aging, acquire aesthetic values. A F7' wooden table, for example, becomes more valuable and aesthetically pleasing when it have been used and has aged. Participants (F7, CM1) stated that those aged products gave warm feeling, and antique beauty.

Meanwhile, in case of artifacts made of artificial material, the material traces seemed to be considered unaesthetic. Participants stated that such analog artifacts lost its original aesthetic quality due to the traces. Though some products that were made of natural material such as leather, wood or stone were less likely to get damaged, the traces damaged aesthetical appearances of products made of artificial materials (plastic, stainless etc.).

About Historical Value: Participants were able to recall their past experiences related to the artifacts by recognizing the material trace as a channel for recollection. M4 described his old baseball glove and told us that worn traces on the glove expressed the time and effort that he spent for the activity. M8 even mentioned that he wants to hand in his book that shows his past efforts to his child: "I have collected workbooks that I studied to enter the university. Since the traces symbolize my efforts and time, I could not throw them away. I will show them to my future children."

About Authentic Value: During interviews, we could observe that participants' analog artifacts could become visually unique by accumulated traces. Though most analog artifacts are mass produced, like the cases of CM1's wallet and M1' blue jeans they became visually distinctive by virtue of material traces.

About Functional Value: From the utilitarian perspective, material traces sometimes improved functionality of analog artifacts.

We found that several artifacts had changed physically in the process of interacting with users or the environment. For instance, M5's soccer shoes did not fit right to begin with, but the leather of the shoes gradually stretched and now he felt comfortable wearing them. Although they are shabby and old, he said he would use them more. Or the intentionally left traces could be useful to give information for later use. The dog-eared pages or highlighted lines were mentioned by M8 and CM2. At the same time, several participants considered some material traces causative of breakdown of analog artifacts.

3. 2. Traces of Digital Devices

3. 2. 1. Examples of Traces of Digital Devices



Figure 4 Examples of digital artifacts (F4's mobile phone, M7's CD player, M1's mobile phone)

In the case of digital devices, we could observe material traces such as scratches and abrasions, mostly around hardware user interfaces of digital devices or back sides of them (Figure 4). In case of M7's CD player, we could observe several scratches' around the physical user interface. As this part was touched several times, the color layer was peeling off. Additionally, none of participants intentionally left material traces on the digital device such as engraving a name or drawing. Besides the material trace, several digital devices were having informative digital traces that were created automatically. During the interviews, recent call logs of mobile phones and recent playlists in music devices were mentioned by participants (e.g., CM3, F1, M1).

3. 2. 2. Impacts of Traces on Digital Devices

About Aesthetic Value: Participants were less tolerant of material traces on digital devices. Thus, it was difficult to find digital devices that are considered more aesthetic with material traces: "I have used this CD player from my middle school. Though I carefully used it, the paint near the buttons was rubbed off and there are lots of scratches on the body" (M7). The material traces were easily accumulated near PUIs. About the change, participants considered the original aesthetic state of devices were ruined. Compared to analog artifacts, participants tended to avoid these material traces on digital devices desperately even by using additional covers for them.

About Historical Value: Because digital devices are mainly used by individual users or material traces are avoided, it was rare for participants to connect accumulated material traces with other person or important events. Rather than the material traces of digital devices, the digital traces such as past music play list or activity logs could make users think of past experiences. F2 stated digital traces in her mobile phone application: "This application (Nike Running) tracks my progress. I feel proud of myself when I look at what I achieved and it motivated me."

About Authentic Value: In this study, we could not find the case when traces increase authentic value of digital devices. But we could confirm the needs for uniqueness about the devices from how participants decorate their devices using additional stickers and covers. F6 mentioned that she decorated her smart phone with a sticker because she wanted to make her phone different. Moreover, because digital traces were not exposed, digital traces rarely affected authenticity of a digital device.

About Functional Value: In general, material traces of digital devices had negative influences on functional qualities. For instance, F4 mentioned that traces near PUI made the control of the device difficult: “The home button of my phone became loose after using it one year”. In case of some digital devices, scratches or cracks on the displays disrupted severely using the devices. Because most of user experiences happen using the display and a few buttons, even small material traces were considered negative. On the other hand, the digitally created traces were used to improve functionality in the digital devices’ software. For instance, they are used to make shortcuts and quick list (ex. Latest call log in M1’s mobile phone).

3. 3. Traces of Digital Contents

3. 3. 1. Examples of Traces of Digital Contents

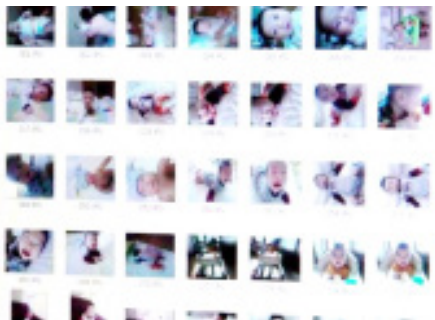


Figure 5 Examples of digital content (M4’s photo)

Digitally generated traces of digital content are usually generated as metadata inside service systems. In case of digital photos (ex. M4’s photo in Figure 5), several digital traces were automatically made such as edited time and date, person who edited it, etc. On the other hand, there were some instances that people added or edited digital traces. Several participants described the importance of digital traces that they intentionally made on digital contents (e.g., digital documents, digital photos). CM1 stated that he highlighted the important sentences in yellow and left several comments as he read digital documents: “I have gathered PDF files as references for my research. When I read them, I leave notes and highlights by using Adobe Reader. The files with digital traces that show my history are more precious than other files.”

3. 3. 2. Impacts of Traces on Digital Contents

About Aesthetic Value: Because digital traces of digital contents are kept invisible or usually used for utilitarian purposes, there were no examples that were not related to aesthetics. Also, compared to the material traces of artworks, the digital traces were only shown as texts and numbers which are far from increasing aesthetic values.

About Historic Value: In analog artifacts, material traces are accumulated through a passage of time. On the contrary, participants frequently mentioned that digital contents such as music or movie files that participants bought do not show historic values because their digital traces are easily updated or not accumulated. For this reason, M3 stated that he prefers physical books to digital documents since physical books are keeping traces that show his efforts. Likewise, since the digital traces of using digital contents are not saved, participants could not feel historic values from digital contents.

About Authentic Value: During the interviews, we could observe that the authentic value of digital contents could be increased by the digital trace. Discussions with CF1 and CM1 also illustrated the authentic value of traces on digital contents: “We select and rate good pictures after a trip. In this software, we can rate from 0 to 5 stars according to the opinion. This process is fun to do together. Compared to unrated pictures, rated pictures become more precious and unique for us.” CM3 mentioned that while he usually reads PDF documents, he highlights important sentences or put comments about them. Thought it is possible to download the same PDF documents online, he stated that he wanted to only keep the documents that he has used.

About Functional Value: Unlike analog artifacts, digital devices and content systems take advantage of digital traces such as metadata to provide convenience to users. An illustration of this was given by CM3, who often uses his mobile phone for listening to music: “I can read recent music lists in the phone. Though they do not have a significant influence on usability, I use them sometimes as a shortcut or as useful information sources for recalling something.”

4. Discussion

Regarding the aesthetic, historic, authentic and functional values by artifacts’ traces, we could confirm that the use of digital traces has been limited for designing emotionally valuable digital artifacts. Especially, we could find that most of digital devices and digital content were using digital traces for utilitarian purposes; increasing efficiency or giving useful information. However, as the emotional values of analog artifacts sometimes improve with material traces, these findings suggest design issues and possible opportunities for utilizing digital traces in digital devices and content systems. As shown in Table 3, there were design spaces that were rarely explored or spaces in which only negative impacts were investigated. Through repeated discussion and modeling sessions within our research team, we identified specific opportunities areas to cover the design spaces and guide future research and practice in the design community. In this section, we explain each issues and opportunities by illustrating with existing design cases.

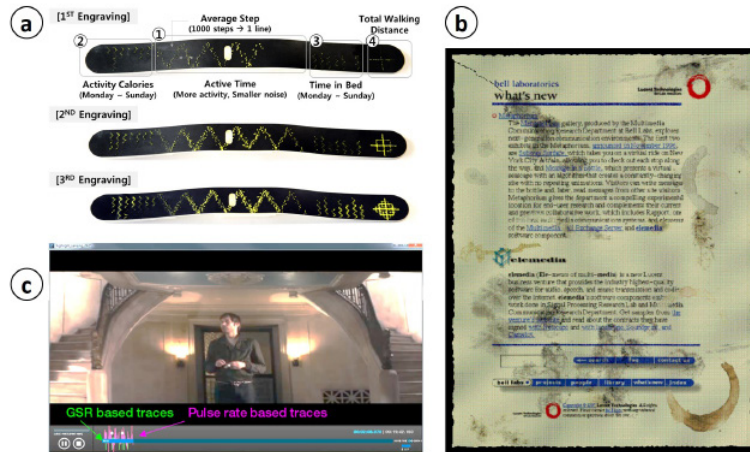


Figure 6 Examples that use traces in the digital domain: (a) Patina Engraver (Lee et al., 2015, b), (b) Live web stationery (Doree and Stephan, 1997), (c) Video player that gathers viewers' traces (Lee et al., 2015, a)

4. 1. Giving Meaningful Forms to Digital Traces

Because the functions and operation of analog artifacts are relatively simple and dedicated to specific purposes, the material traces that are generated while using the artifacts is informative enough to remind users of the past experiences. For example, M6 could look back on the past experience of doing baseball when he looked at the wear on his baseball glove. From this perspective, current digital devices and content systems are not suitable to generate meaningful traces that remind users of their past. For instance, though the wear around a play button of M7's CD player may show how much the user likes listening to music, it is difficult to guess meaningful information such as which song is favorite, when it is used, what kind of genre is often played etc. Likewise, even if a digital device gathers material traces similar to that of an analog artifact, compared to the complex functions that the devices provides, material traces around interfaces are not informative enough to remind users of past memories.

In case of digital contents, their digital traces are hidden in general. Thus, it is difficult for people to check the histories from the trace. For this reason, digital contents hardly gather emotional values by digital traces. However, as found in the study, digital traces such as call logs or recent music history have several advantages. Unlike material traces, it can contain detailed information which may enrich users' reflection on their past.

Design opportunity 1: Considering latent values of digital traces which can explain details of past histories in digital devices and emotional values of material traces, it will be beneficial to physically materialize the digital traces by using data visualization and digital fabrication technologies. Although material traces in digital devices have been rarely studied, it would be possible to generate meaningful material traces on digital devices if the material traces are generated according to the devices' digital traces. For instance, Patina Engraver makes patina-like patterns on activity trackers based on users' activity histories (Figure 6.a). In their work, they found that material traces on the device enrich aesthetic, historic, authentic values (Lee et al., 2015, b).

Likewise, by exploring diverse materials, data visualization, and fabrication technology together, it will be possible to generate meaningfully-shaped material traces on digital devices by physically visualizing digital traces.

Design opportunity 2: In case of digital contents, because their digital traces are hidden usually as metadata, it is difficult for people to check the changes of the trace. To increase visibility of digital traces, it is necessary to consider how digital traces can be shown in an ambient way like material traces. For example, Doree and Stephan produced an experiment in which a web page ages as if it were a physical piece of paper (Figure 6.b). Based on human and environmental conditions, Live Web Stationery web page shows graphical wear such as smudges, rips, stains and fading (Seligmann & Bugaj, 1997). As shown in the work, rather than hiding digital traces, digital content service may need to show digital traces in ambient ways.

4. 2. Archiving Digital Traces rather than Updating

In case of analog artifacts, material traces are indelible and it takes effort to erase them on purpose. Whether the material trace is positive or negative, it is found that participants can reflect on the past from the indelible trace. Likewise, the inalterability and accumulation of digital traces may induce the user to feel historical and authentic values about the artifacts.

Design opportunity 3: Unlike material traces, digital traces in digital devices and content systems are generally easily replaced, updated, or erased. For instance, when using a document file, the digital traces such as edited time or person who edited it are updated easily. While current services focus on updating recent traces, as tried in previous research about using digital traces for video content services (Lee et al., 2015. a), it will be possible to accumulate users' digital traces which are helpful for reflecting on personal histories. In Lee et al.'s video system (Figure 6.c), as people cherish physical books and leave traces about their feelings, people can accumulate personal digital traces such as their bio-signals and comments about video content in the system. Likewise, digital traces can be stored and archived to enrich historical and authentic values of digital contents.

Design opportunity 4: In digital domain, digital trace can be diversified using diverse sensors or logging mechanisms. For instance, digital traces by sensing bio-signal such as pulse rate, breathing pattern, or body heat partly reflects emotional changes of people (Detenber et al., 1998; Lee et al., 2015. a). If then, music devices or service systems as an example may be designed to show users' history about what the most touching songs have been based on the digitally gathered traces of the user's physiological changes instead of just keeping track of frequently played songs. This kind of diversifying digital traces suggests an opportunity to design digital artifacts that stimulate users' reflection with more concrete evidence that shows past emotional status.

5. Conclusion

As an early attempt to explore issues of making more emotionally valuable digital artifacts via digital traces, this paper drew upon the investigation of what kinds of material and digital traces are constructed and compared how the traces affect artifacts' emotional values. Through the analysis of field study results, we discuss how digital traces can be used as a foundation for enhancing emotional values of digital artifacts. Since the participants of the research were restricted in their 20s and 30s, further researches need to cover participants from different age groups who may suggest alternative results. Nevertheless, considering the paucity of work in this area, this paper makes a contribution by offering an analytic perspective on traces and applying the concept of patinas to the digital domain.

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