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Master's Thesis

# SLOWPIXELS: Slow-design for reflective retrieval of personal photos

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2020

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A thesis submitted to the Graduate School of Creative Design Engineering,  
UNIST in partial fulfillment of the requirements for the degree of  
Professional Master of Design-Engineering

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01.10.2020

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Advisor

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# SLOWPIXELS: Slow-design for reflective retrieval of personal photos

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## Abstract

We introduced the design and findings in our user study of SLOWPIXELS, a photo printer which aims to stimulate reflection & memory recall through the re-materialization of digital photos. Photos were serendipitously retrieved dependent upon position of two sliders: When did I take the photo (photo date slider) & Where did I take the photo (distance from home slider). SLOWPIXELS used its owner's Instagram account metadata. We tested SLOWPIXELS to 20 participants for 11 days to investigate how the Slow-design could support reflective retrieval of personal photos. Findings revealed that SLOWPIXELS encourage users to reflect their past by unexpected pictures and promote their social bond. We also found that SLOWPIXELS has a design possibility in the public space for event-like situation. For example, in café or student community centre. These findings suggested several contributions, such as designing for revisiting serendipitous memories on the past, empowering social communication, and new way of retrieval of photography while exploring the slow-design agenda within the Design Research community.

Keywords: Slow Technology; Slow Design Principles; Digital Photography; Interaction Design;

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CDE 친구들 - 헤민, 보민이, 자영 언니 특히 고맙습니다. 모두 바쁘고 힘든 대학원 생활일텐데, 언제나 제 곁에 있어줘서 많은 힘이 되었습니다. 그리고 904 호에서 같은 랩 소속처럼 챙겨주신 김관명 교수님, 항상 따뜻하게 대해 주셔서 감사했습니다. IID 랩 오빠들 - 1 학년 때 대학원 처음 들어와서 힘들었을 때 가장 큰 도움이 되어 준 Tufail & 박상진 오빠, 동생들 참 잘 챙기는 주상진 오빠, 재한씨도 감사합니다. 동갑이지만 배울 점이 참 많은 양사장님 지현이, 우직하고 성실한 재희, 항상 묵묵히 도와준 든든한 용준 오빠, 티나인 진희 & 가을이, 캐드실의 해결사 교휘 오빠, CDE 동기들 하연 언니, 소미, 상현 오빠, 성호 오빠, 그리고 우리 랩 남철, 일희, 같이 팀플 하면서 코딩 & 개발 많은 도움 주신 허윤님께도 감사드립니다. 되돌아 보니 방콕 워크숍, KIDP 국제 디자인 융합 캠프하며 친해진 여러 외국인 친구들까지 정말 많은 사람들과 많은 추억들이 있었네요. 잊고 있었는데, 이렇게 적고 보니 제가 참 인복이 많은 사람인가 봅니다. 항상 이렇게 제 옆에 있으면서 도와주신 분들이 있었기 때문에 제가 졸업을 하는 날이 올 수 있었어요. 그밖에 여기에 미처 적지 못한 CDE 친구들, 선후배들, 교수님들, 행정실 선생님들과 육기철 선생님까지도 모두 모두 감사드립니다.

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## Introduction

### Background

The dematerialization of digital contents has made it easy for people to search and share the digital contents. Because dematerialization occurs when content becomes disengaged from fixed carriers, and flows freely through networks and devices (Dourish, 2001). It has enabled people to create numerous digital files over time. As an example of social media service Instagram, since its creation, more than 40 billion photos have been shared. 95 million images are also uploaded every day on Instagram (Lister, M., 2019). Over time, the size and scale of digital contents continue to grow.

However, several problems occurred. First, as digital photo becomes intangible and photo archives grow bigger, it makes people can hardly grasp how big their archives are. People take a picture habitually in their daily lives, but they often forgot why they kept them, because of that massive quantity. Second, digital photo also enables people to have difficulty in organizing, managing, and reflecting on them (Sellen, A. et al., 2007) (Petrelli, D. et al., 2010) (Van House, N., 2011). Finally, as digital photo becomes ubiquitous across digital devices and social media, it makes difficult for people to retrieve it reflectively (Odom, W., 2012). Therefore, there is less opportunity for reflection, contemplation and reminiscence in current digital photography experience.

In this regard, several researches which aims at reflection & slowness have been studied in HCI field (Hallnas, L. & Redstrom, J. 2001) (Odom, W. et al, 2012) (Tsai, 2014) (Mols, I. et al, 2017). Photobox (Odom, W. et al, 2012) and The reflexive printer (Tsai, 2014) used random photo printing to simulate reflection and re-visitation. ChronoScope (Chen et al., 2019) also used time metadata to retrieve the digital photography. Examples in Six Slow Design Principles (Strauss, C. et al., 2008) also aimed to promote reflection and meaningful interaction (Grosse-Hering, B. et al., 2013) However, there were no design works using both time and location metadata to support reflection in retrieving & printing the digital photography.

We designed SLOWPIXELS which encourages users to reflect their past while retrieving & printing photo from the user's Instagram photos. It employed two selection criteria: (1) Far to Near (photo

distance from where product exists) (2) Old to New (photo date). In contrast to conventional photo retrieval through smartphone, metadata has been used in photo selection, providing unexpected & physical photo retrieval to stimulate reflection & memory recall. Thereby slowing the photo retrieval experience. We tested SLOWPIXELS to 20 people for 11 days with interviews about the experience of it compared to smartphone. Then we categorized the results into two Slow Design Principles.

In this result, findings revealed that unexpected pictures encourage users to reflect their past and promote their social bond. We also found that SLOWPIXELS has a potential in the public space for event-like situation. For example, in café or student community center. These findings suggested several contributions, such as serendipitous & surprising memories on the past, empowering social communication, and exploring the slow-design agenda within the Design Research community.

### **Research Aim and Scope**

The aim of this study was to investigate how slowness may support experience of reflection in retrieving personal photos. This research was based on the 'Slow Technology' and 'Slow Design Principles' approach which induces reflection rather than efficiency (Hallnas, L. & Redstrom, J. 2001). This study was also followed the research through design process (Zimmerman, 2007).

## Theoretical Framework

In this chapter, we investigated the relevant design works and researches. The research scope was categorized with 2 parts: Slow technology for reflection and Slow Design Principles. Some researches may belong to both groups at the same time, so it may be pointless to divide them. However, each of these groups was divided based on the points that we would like to note and refer to. In the first part, we explored the 'slow technology'. There were some cases which investigate the slow technology agenda to support reflection and mental rest rather than efficiency in performance (Hallnas, L. & Redstrom, J., 2001). It also usually uses an elementary technology and needs time for learning how it works. In the second part, we found some researches exploring 'Slow Design Principles' to make people reveal, reflect, expand, evolve, engage, and participate.

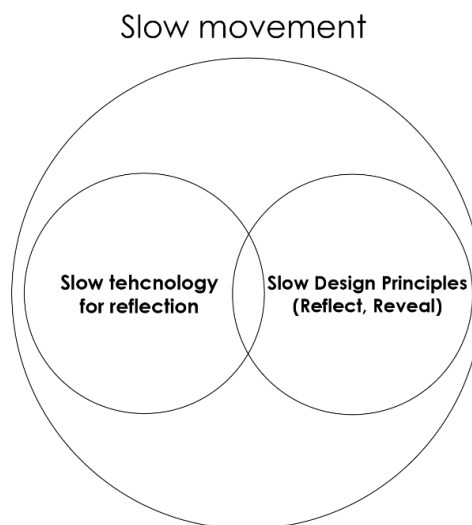


Figure 1. Related Works Scope

### 2.1 Slow technology for reflection

*Photobox : On the Design of a Slow Technology*

'Photobox' aims at supporting anticipation and re-visitation of the past expanding the slow technology agenda (Odom, W., 2012). It randomly prints user's photo from the Flickr account of users.



Figure 2. Photobox (Odom,W., 2012)

*CrescendoMessage: interacting with slow messaging*

‘CrescendoMessage’ used temporal expression of slowness using four gradually clearer images (Blur-Christal-Pixel-Once). Chatbot (actually, Wizard of OZ) sends four images sequentially to the group chat room at regular intervals. The participants were invited to evaluate the reminiscence, feelingfulness, curiosity, recognizability, and coincidence of each four image on a likert scale up to 1-5. In conclusion, the uncertainty and ambiguity of communication triggered anticipation, reflection and sensibility.

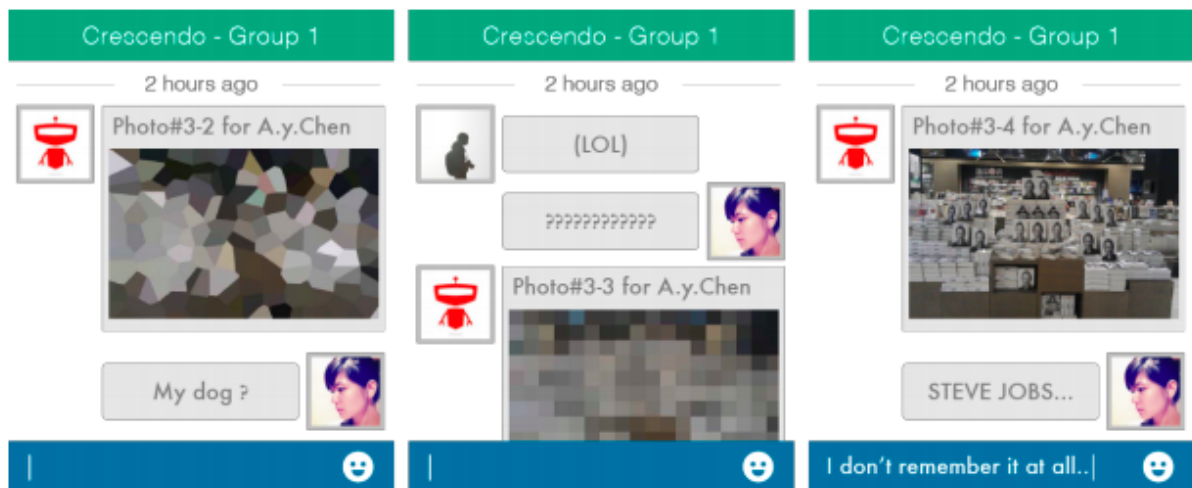


Figure 3. Conversation windows for delivering crescendo messages (Tsai, 2015)

*The Reflexive printer: Toward Making Sense of Perceived Drawbacks in Technology-Mediated Reminiscence*

‘The reflexive printer prints random photo with very slow interaction – one photo a day. It uses thermoelectric printers to print Black and White-Halftone Image. It deletes the printed photo from the smartphone to enrich daily reminiscence.



Figure 4. The reflexive printer (Tsai, 2014)

## 2.2 Slow Design Principles

*The Slow Design Principles – A new interrogative and reflexive tool for design research and practice*

Table 1. Six Slow Design Principles (Strauss, C., et al., 2008)

<u>Slow Design Principles</u>	<u>Description</u>
<b>Reflect</b>	Slowly-designed artifacts/environments/experiences induce contemplation and what slowLab has coined ‘reflective consumption’.
<b>Reveal</b>	Slow design reveals experiences in everyday life that are often missed or forgotten, including the materials and process that can be easily overlooked in an artifact’s existence or creation.
<b>Engage</b>	Slow Design processes are open-source and collaborative, relying on sharing, co-peration and transparency of information so that designs may continue to evolve into the future.
<b>Participate</b>	Slow Design encourages users to become active participants in the design process, embracing ideas of conviviality and exchange to foster social accountability and enhance communities.
<b>Evolve</b>	Slow Design recognizes that richer experiences can emerge from the dynamic maturation of artifacts, environments and systems over

	time. Looking beyond the needs and circumstances of the present day, slow designs are (behavioural) change agents.
<b>Expand</b>	Slow design considers the real and potential ‘expressions’ of artefacts and environments beyond their perceived functionalities, physical attributes and lifespans.

We investigated Slow Design Principles (Strauss, C., et al., 2008) to encourage more meaningful interaction to support reflection & memory recall. Strauss firstly introduced the six Slow Design Principles in their paper, ‘The Slow Design Principles - A New Interrogative and Reflexive Tool for Design Research and Practice’ (2008). Originally, these principles are evaluative tool to encourage design outcomes to aim at social, cultural, and environmental sustainability under the ‘Slow Design’ agenda. In this study, we applied two design principles of ‘Reveal’ and ‘Reflect’ into our research product. In other words, we tried to reveal the meaning of photography that is often missed or forgotten in people’s everyday life and induce a reflection when they recall their memory through photography.

## 2.3 Analysis of Photo activity

### *Classification of photo activities*

We investigated the photo activity to support reflection & memory recall through digital photography. Based on the previous study (Broekhuijsen, M. et al., 2017), we could classify the process of photo activity into four categories: Accumulating, Curating, Retrieving, and Appropriating (Table 2). In this study, we concentrated on the ‘Retrieving’: viewing, searching, and browsing. Because we assumed that there is no opportunity for reflection, contemplation, and reminiscence when people view, search, and browse their digital photo albums, due to their massive amount. Photography also enables people to reflect their past while they retrieve their personal photo archives (Mols, I. et al, 2017).

Table 2. Classification of photo activities (Broekhuijsen, M. et al., 2017)

<b><u>Photo activity type</u></b>	<b><u>Photo activity category</u></b>
<b>Accumulating</b>	Capturing, Collection, Collecting
<b>Curating</b>	Triaging, Organising, Managing, Editing
<b>Retrieving</b>	Browsing, Viewing, Searching
<b>Appropriating</b>	Sharing, Printing, Tinkering, Collaging



*Photo activity: Retrieving*

In details, there are three activities in 'Retrieving' photography. First, 'viewing' is a passive viewing of slideshow. For examples, people see their digital photography through a screen or a display, while they see it through film or paper albums in analog photography. 'Searching' is a goal-oriented retrieving which was often annoying for some people. Due to a huge digital photo archive, people nowadays have difficulty in finding a specific photo (M. Broekhuijsen and P. Markopoulos, 2017). On the other hand, 'browsing' is more closed to a casual viewing of pictures. For examples, people sometimes just look through their photos and recall their past with their smartphones when they feel boring. In the past, they look through their family photo albums or photo frames at home when they miss their family members, or they want to reflect their past.

## Design & Development

While retrieving photography with SLOWPIXELS, people could think more about their personal photo archives than smartphone. Because there was no display, they don't know which pictures come out. Like a film printing, people anticipate and wait until the picture printing is completed. Photos are also retrieved according to two criteria: time & distance. Users can 'search' or 'browse' each range of time & distance, but SLOWPIXELS sometimes prints out unexpected pictures from their photo albums. This experience 'reveals' the forgotten photos hidden by the numerous photos. This randomness of photography can also induce a 'reflection' (Odom, W. et al., 2012)

SLOWPIXELS is a personal photo printer to stimulate reflection & memory recall through the re-materialization of digital photos.

Photos are serendipitously retrieved dependent upon position of two sliders: When did I take the photo (photo date slider), Where did I take the photo (distance from home slider)



Figure 5. Functions

### 3.1 Design features

#### Functions

We designed the SLOWPIXELS based on two slow design principles (Strauss, C., et al., 2008), Reveal and Reflect. SLOWPIXELS has three functions (Figure 5). First, photo date slider explores the time from

when the picture was taken to the present (Old – New). For example, if users want to find a picture taken the longest time ago, move the slider to the far left. Then, LED lights come to the place where it says 'OLD'. Second, distance slider explores the photo distance from where the photograph was taken to where the product (usually user's home) is currently located (Near-Far) . For example, if users want to find a picture taken from the farthest distance, pull the slider to its fullest extent. Then, LED lights come to the place where it says 'FAR'. Lastly, after browsing the time and distance, press the button to print out the photo.

#### *Product Design – Form & CMF*

We intended the SLOWPIXELS form design to appear similar to other analogue products such as radio to provoke a sense of warmth. Material of SLOWPIXELS was composed of two components: Plastic upper & middle case, hard maple wood bottom plate. We chose two comparative materials – plastic & wood - to present a contrast with high technology (Figure 6). We also decided to use wood material for where analogue interaction was used, time and distance sliders. However, we used stain-less steal where the digital interaction was used - print button on the top. Also, we put leather strap to make it aesthetic and portable.

## Form.

Moac Studio (<https://moakstudio.com/>)



Hilo speaker



Dina



Vole Lamp

Figure 6. The metaphor of form

SLOWPIXELS used white and warm grey color. It also used both plastic and hard maple wood material to give an analog feeling with brown tan leather strap.

## CMF.

Color, Material, Finish



Figure 7. Color, Material, Finish

### *Interaction Design*

SLOWPIXELS used tangible interaction to search and browse the photo using slider. Because we thought that it gives people time to think. Unlike smartphone, people can't see the pictures through screen. However, they can browse the pictures while guessing using sliders. We applied two Slow Design Principles (Strauss, C. et al., 2008) to our product's interaction design. The time slider was inspired by radio frequency dial and the distance slider was inspired by radio antenna (Figure 8). As if to tune the frequency of the radio, the process of navigating pictures through physical interaction makes people think about what pictures will come out. Because there is no screen or display, so users should rely on LED and the word, Old-New & Near-Far (Reflect). And just as the radio sometimes accidentally finds unexpected sounds in the lots of frequency, a printed photo, controlled by the time and distance sliders, sometimes reveals an unexpected photo that has been forgotten in countless photographs (Reveal).



Time  
(Radio frequency slider)



Distance  
(Radio antenna)

Figure 8. Metaphor of interaction (Left: 'Braun tp1' & Right: 'Braun radio type 4826' by Dieter Rams)

### 3.2 Design process

*An initial concept sketch of the pixelated photo printer*

We initially have developed the pixelated photo printer (Figure 9) in order to support reflection and refresh the trend toward higher resolution technology. First, we intended to make people slow down, contemplate and reflect through abstract image (Tsai, 2015) (Mols, I. et al, 2017). Second, we utilized the location meta-data to stimulate the user's reflection. Users firstly selected the distance from the picture was taken to the place where product exists by a dial to retrieve their pictures. After selecting the distance, they pulled down the lever like a toaster to print out. Then, the pixelated photo was printed. Two problems were reported in the pilot experiment. The first problem was that the pixelated photo might make a participant frustrated. However, one of our interviewees commented that, "When I see the pixelated image, I'm frustrated." Secondly, we thought not only the location but also the time was important to recall memories through photos. There were several studies using time meta-data as a design material (Chen, A. Y. S. et al., 2019) (Odom, W. et al., 2018). Therefore, we decided to utilize both distance & time to retrieve the digital photography in our final concept. We also used simple button interaction to print out the simple black and white picture for reflection rather than using the pixelated image.

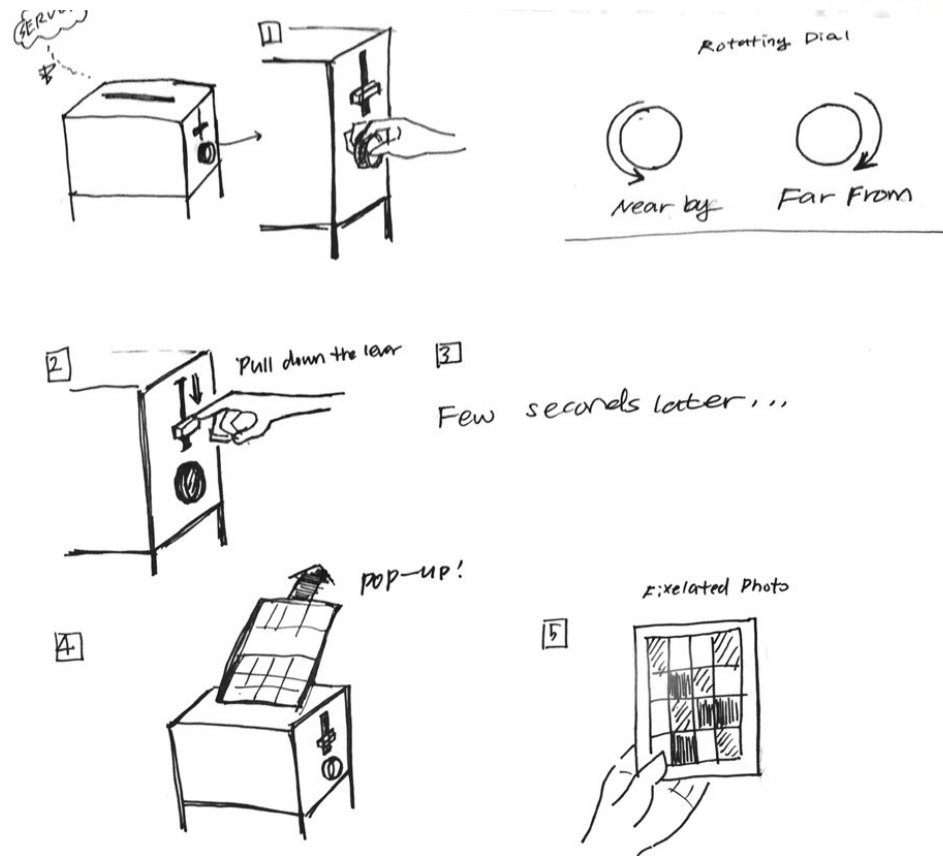


Figure 9. Initial Concept of pixel photo printer using time metadata

## Form & Material

We sketched to find a best form (Figure 10). Then, we considered which material represents our concept well. We finally decided to use plastic, wood, and metal. For the main body, we used plastic for top and middle part and hard maple wood for the bottom part.

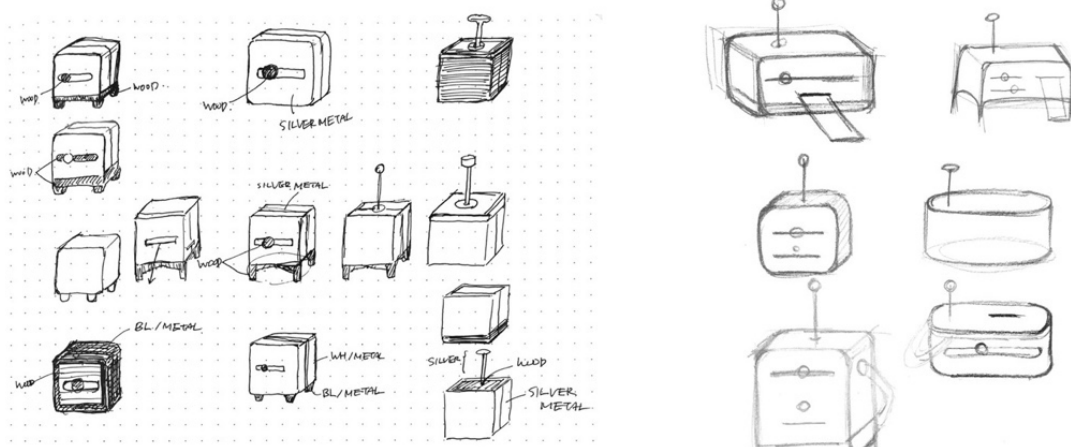


Figure 10. Form & Material



### Structural Design

First, we explored the appropriate size for table-top product (Figure 11). We finally decided the size of 112(W)\*112(H)\*112(D) mm. Second, we considered how to connect middle plastic part with wooden plate. We decided to put four screws on the corners. Third, we put two sliders on the front (time) and top (distance). Finally, we decided the length of the sliders. The printer should be placed on the bottom, so the length of distance slider has become shortened to 30mm, while the length of time was 60mm.

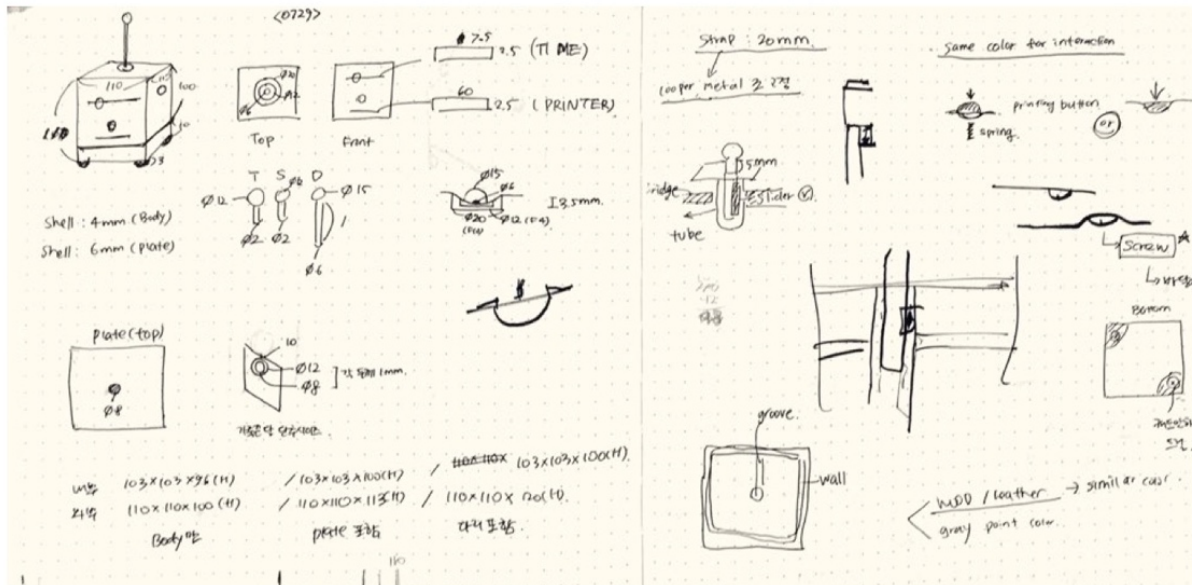


Figure 11. Structural design

### Final Design Concept of photo printer using both time and location metadata

The final design was a cube shape photo printer using both time and location data. The size of the main body was 112\*112\*112 mm so that the user can easily hold it and place it on the desk. We made two versions of working prototypes, white and warm grey, because these colors harmonize very well with wooden part. In case of material, the main body was made of plastic and the bottom plate was hard maple wood.(Figure 12)



Figure 12. Final prototypes

### 3.3 User Scenario

Firstly, the user browses the time and distance of photos from their current time and location (Figure 13- 1,2). When the user presses the button on the top of SLOWPIXELS, the selected picture is printed on a thermal paper (Figure 13-3). The user thinks about their past while looking at the printed picture. Sometimes the unexpected picture comes out and reveals the forgotten memory in their everyday lives. People can use SLOWPIXELS with their friends at the cafe to share surprising memories (Figure 14).



## How to use.



Figure 13. How to use

## User Scene.



*Sometimes I use SLOWPIXELS with my friends at the  
cafe. We share surprising memories with SLOWPIXELS.*

Figure 14. User Scene

### 3.4 Development

First, we designed SLOWPIXELS using CAD (Computer-aided design) modeling by SolidWorks 2019. All parts of SLOWPIXELS were manufactured by CNC (Computer Numerical Control).

#### *Main body*

The main body consisted of three parts: top, middle and bottom (Figure 15). The top part included pulling handle, confirm button and LED. The middle part included the time slider, LED, and printer hole (Figure 15). On the side of the middle part, there were two parts for holding the leather strap. Lastly, the bottom part contained thermoelectric printer, thermal paper roll, press, Raspberry Pi, HAT board, and power button PCB. The top and middle parts were painted through mat-white and warm-grey color spray. Also, the warm-white color LED was installed to show the status of the slider such as old/new or near/far or ready-to-print status.

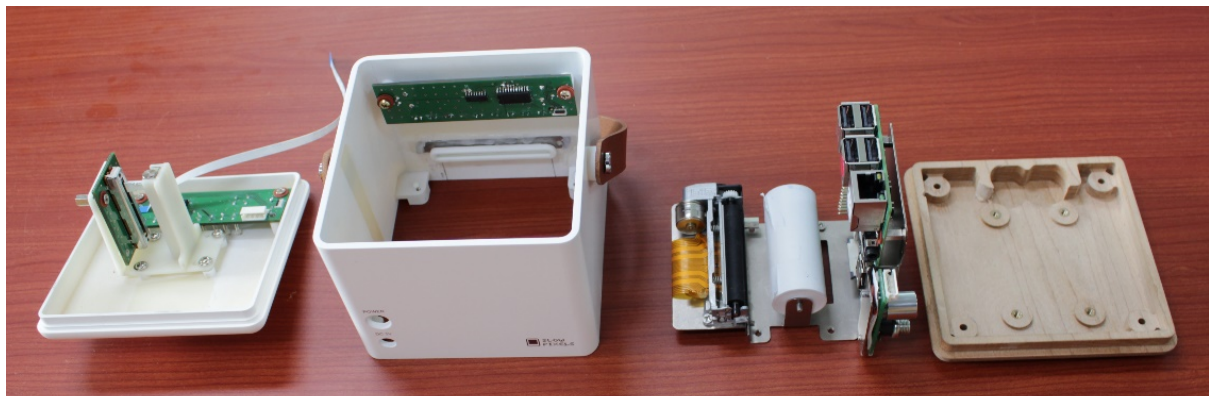


Figure 15. The assembly of the whole part

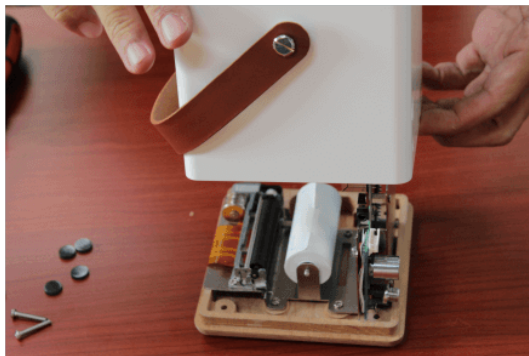
We covered the screw with rubber stickers on the bottom to prevent slipping (Figure 16-1). With four screws, we combined the middle plastic and the bottom wooden part. A printer module has also been placed on the bottom plate.



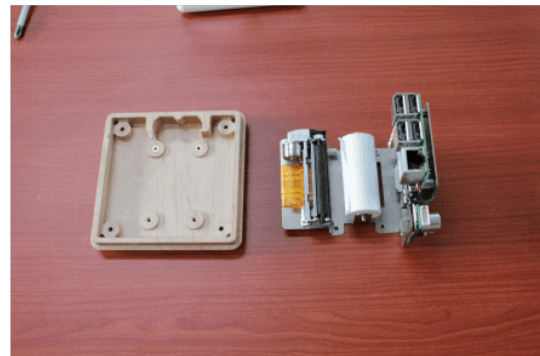
1



2



3



4

Figure 16. The assembly of the bottom part



**Top**



**Middle**

Figure 17. The assembly of the top and middle part

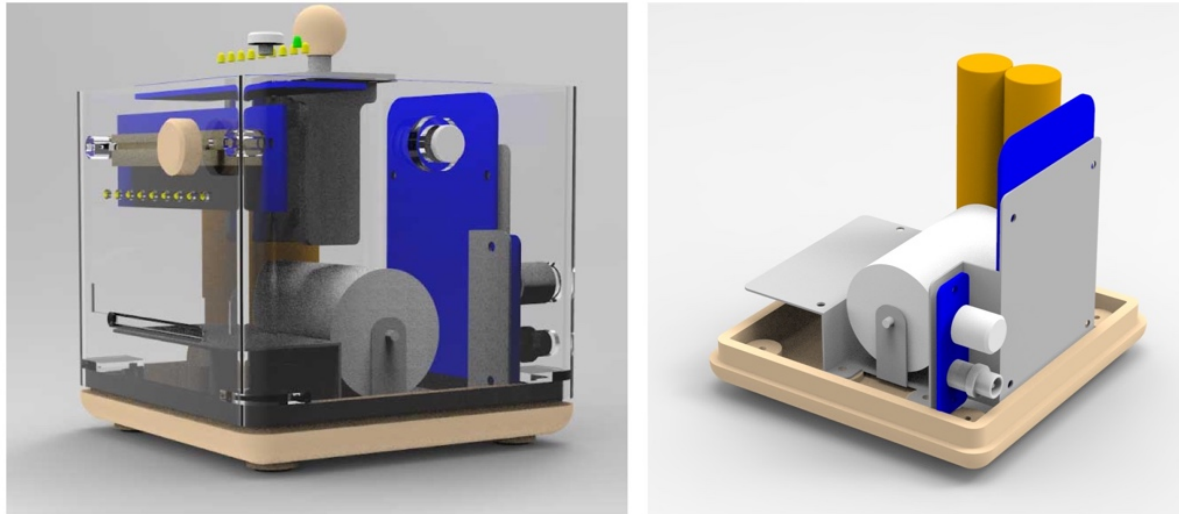


Figure 18. The detailed structure

#### *Wooden part*

We used a hard maple wood for time and location slider handle (Figure 19). To emphasize the analog interaction part, we use the wood material which gives a sense of warm analog feeling. We used the 60mm slider for the linear switch on the front part of the product and the 30mm slider for pulling lever on the top. To keep the compact size of the main body and consider the universal size of the slider switch, we have to shorten the length of the slider on the top than front.

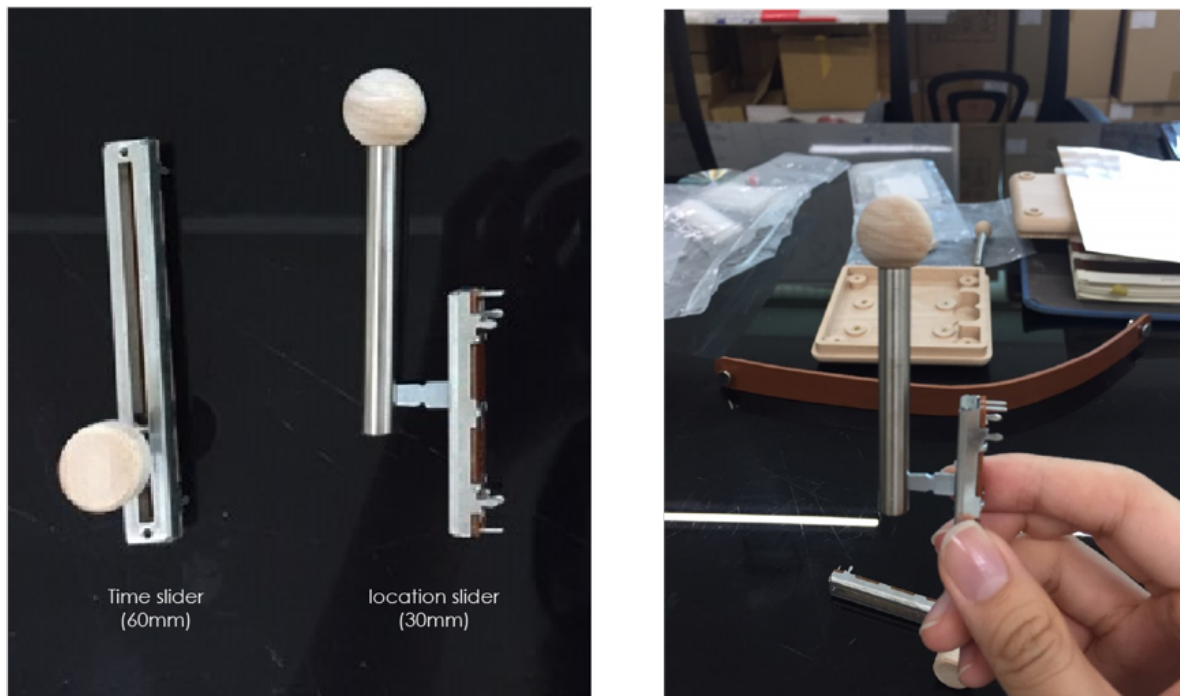


Figure 19. Wooden part for analog interaction



*Wooden bottom plate and batteries*

On the middle of the wooden plate, there were four holes for holding a printer module. Also, on the corner of the plate, there were four screw holes which connects the middle part and the bottom wooden part. We also used two batteries for a portable concept.

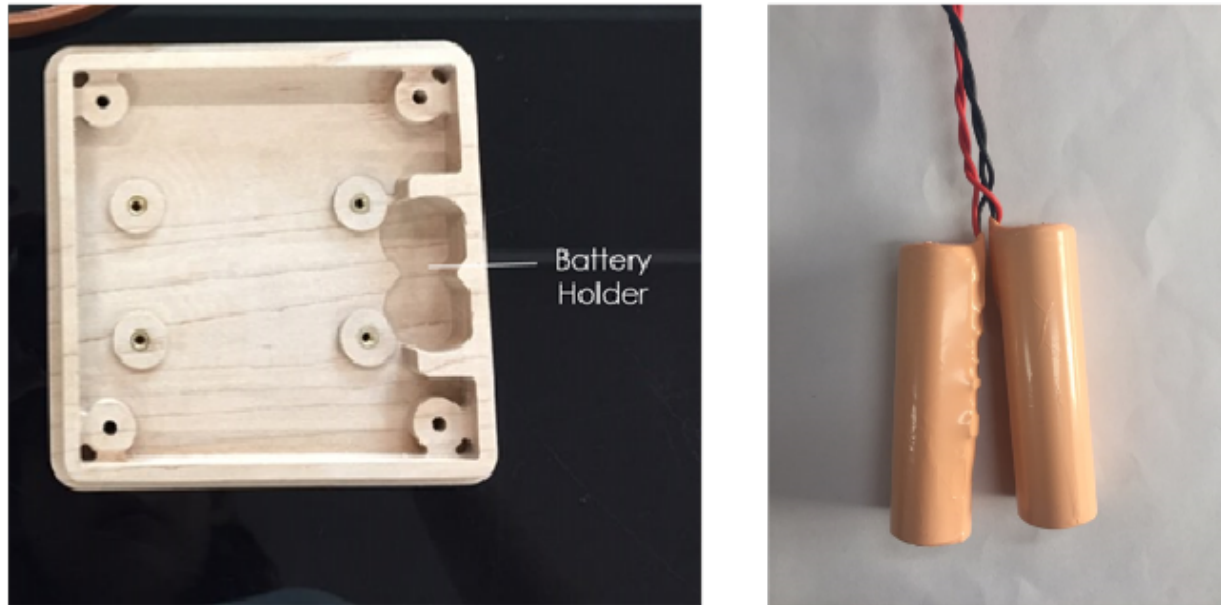


Figure 20. Wooden bottom plate and batteries

*Metal part*

We used the blade of a knife to easily cut the printed paper (Figure 21). We also made some space for the blade to fit in.



Figure 21. The blade of a knife to cut the printed paper

There were four metal parts made of stainless steel. We designed the press for holding thermoelectric printer guts, paper roll and Raspberry Pi. In case of the distance bar, we made a screw thread on the top of a cylinder bar, to connect to a wooden sphere-shaped handle.

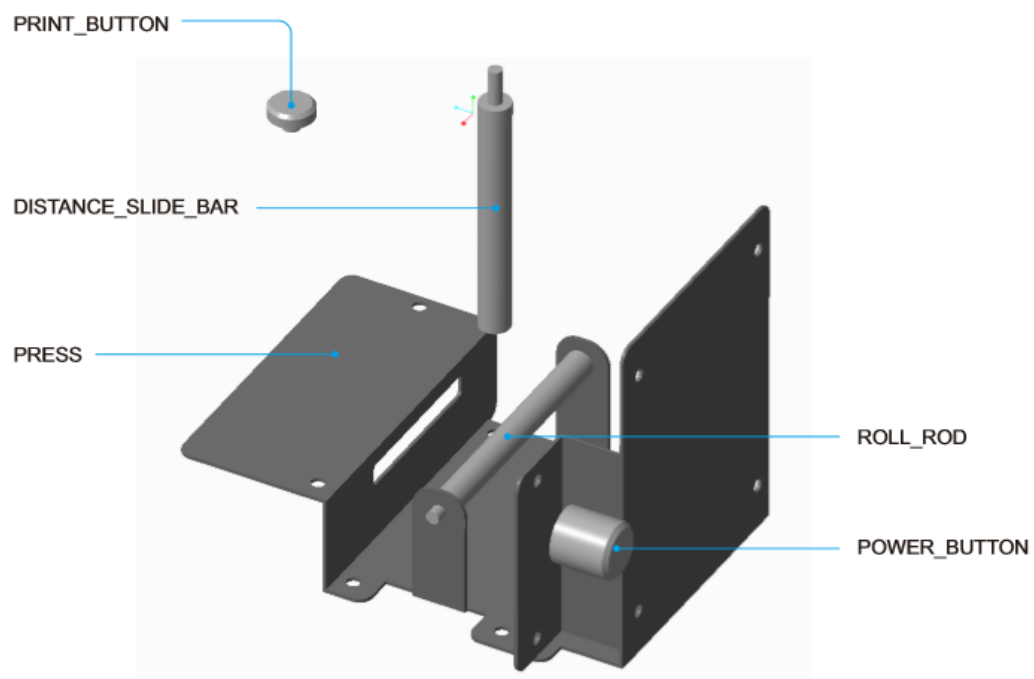


Figure 22. The structure of printing part and others

Confirm print button on the top was also made of stainless steel (Figure 23). We used metal material where a digital interaction was used, in contrast to wood materials where analog interaction was used.



Figure 23. The top side of the white prototype

On the backside of SLOWPIXELS, the power button and 5V DC were located (Figure 24). The power button was also made of stainless, because of the same reason of the confirm button.



Figure 24. The backside of the white prototype

#### *PCB Development*

To design each PCB board, the schematic and PCB Artwork were worked with Altium V17.0. In particular, ATX Power control simulation utilized Simply 8.0, DC-DC Power specialized design tool in the Power electronics field. Below diagram shows how to connect the Raspberry Pi and other boards (Figure 25) Raspberry Pi 3B+ Board was used to handle system integration control. HAT (Hardware Attached on Top) board with a size of 65x56mm interface with a 40-pin header pin has been manufactured separately. To include the circuit for connecting external input/output (I/O) devices, power supply controls, Li-ion Battery charging and printer/GPS module drive boards. The external input/output devices consist of five total units. (1) Time Slider Board, which enters and displays time information (2) Distance Board, which enters distance information (3) A Confirm Board containing a Confirm Key switch for verification before printing (4) A socket connected to a 5V DC power adapter (5) Powerboard containing a power on/off key.



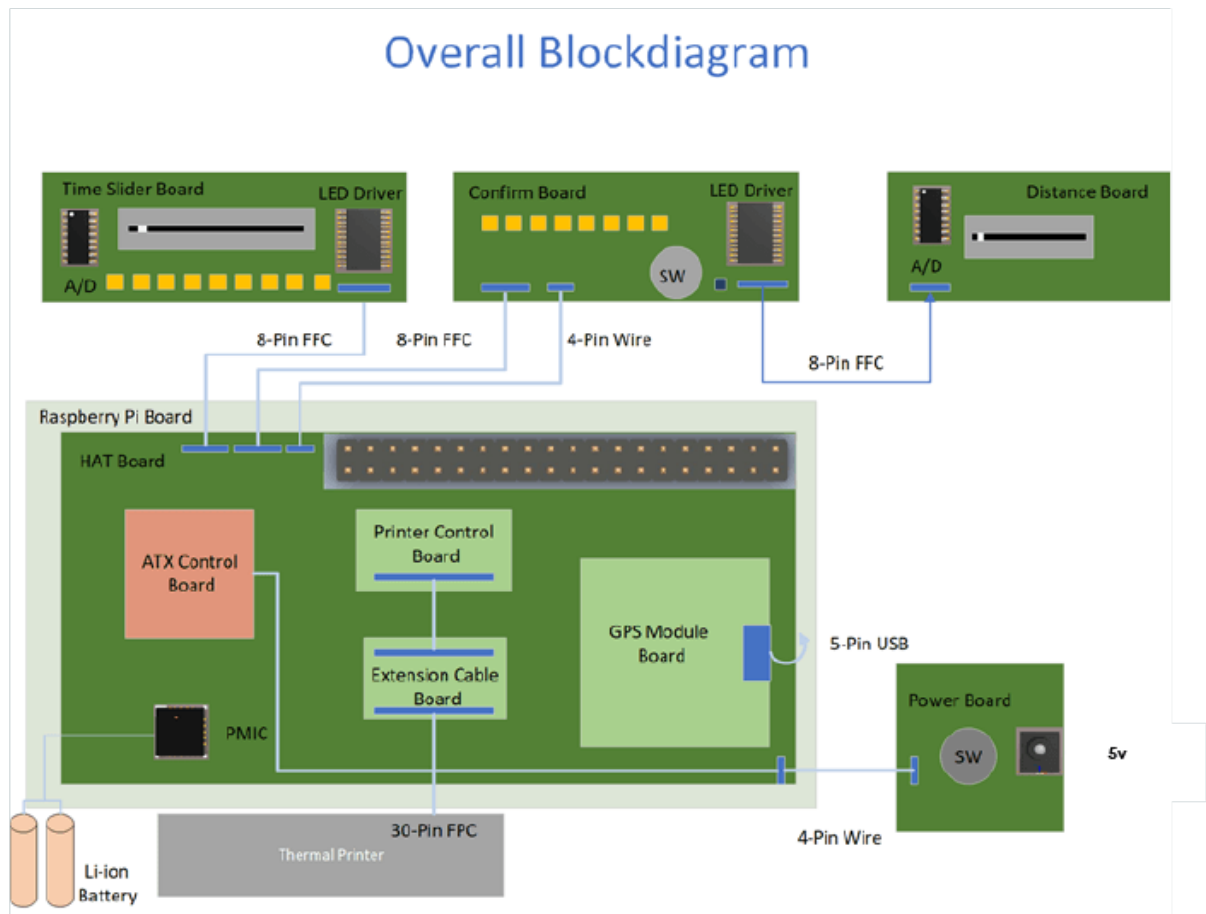


Figure 25. The development of all PCB board

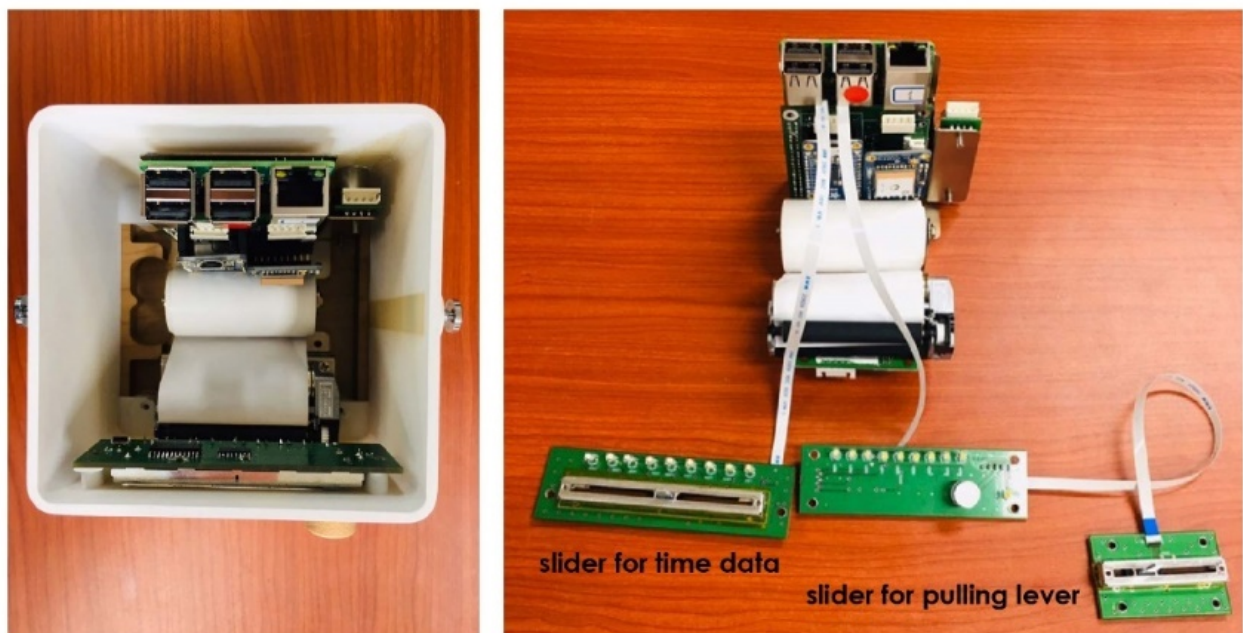


Figure 26. The installation of PCB board

### Logo Design

We also designed the logo inspired by pixel art. The logo was printed using a silk screen (Figure 27) method.

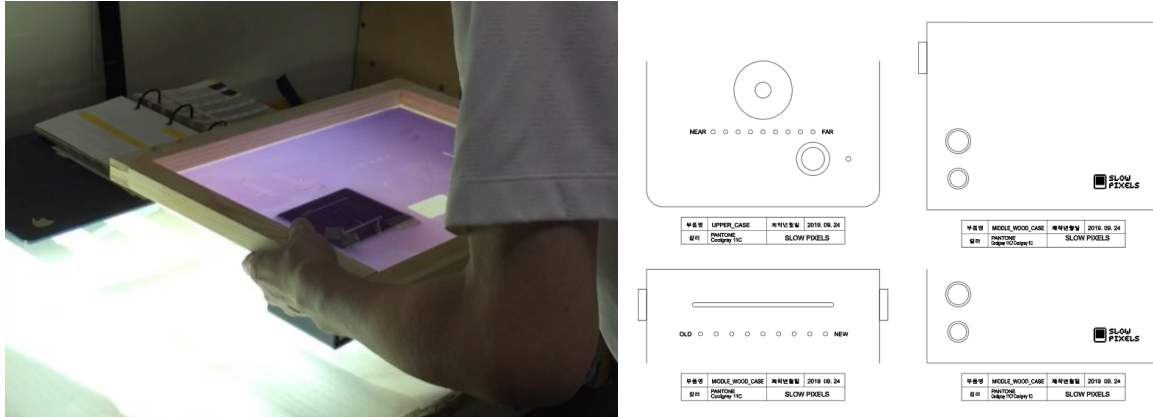


Figure 27. The process of silkscreen

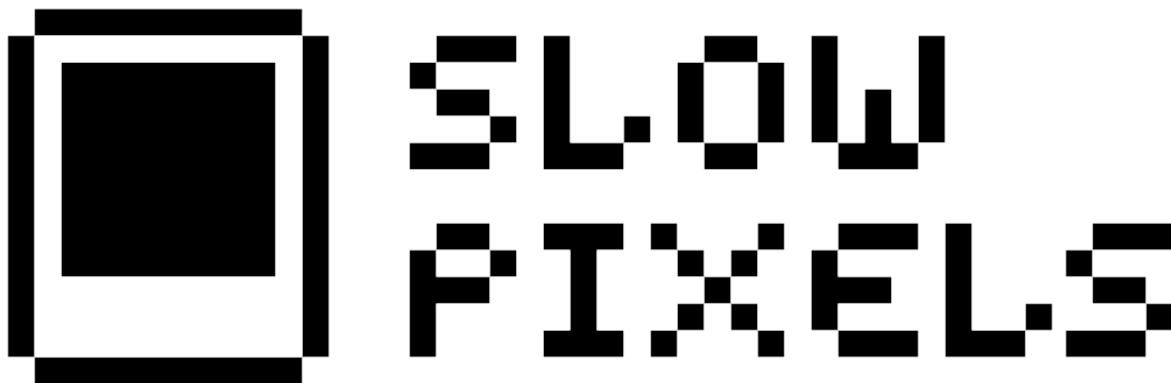


Figure 28. Logo inspired by pixel art and polaroid

### Portable concept using leather strap and battery

We used the brown tan color leather strap and batteries for SLOWPIXELS to make it portable and aesthetic analog sensibility.

## User Study

### 4.1 Study Aim

We conducted an in-lab study with SLOWPIXELS to explore how slow design supports the reflection during retrieving personal digital photography. Through the experiment, we aimed to investigate the following questions: What is the big difference between smartphone and SLOWPIXELS while retrieving and printing photography? How will each participant react when they print out an unexpected picture?

### 4.2 Methodology

#### Participants

We recruited 20 participants from 20 to 29 years old (10 male, 10 female, P1-P20). Two participants in the closed relationship participate in one experiment together, since the experiment was also designed to observe their photo-sharing experience between peers. All teams were composed of friends with 10 pairs (P1-P2, P3-P4, P5-P6, P7-P8, P9-P10, P11-P12, P13-P14, P15-P16, P17-P18, P19-P20). All subjects had Instagram account and more than 20 pictures in their account. Their first photo upload date should be at least six months ago to vary the time frame of the picture. Figure 29 showed each of the 20 participants' age, the number of pictures, the date of the latest uploaded photo and the date of the first (Appendix 1).

## Overview.

In lab study / 10 couples / 20~29

### Aim

to investigate how a slow photos supports the **reflection** during **retrieving** the digital photography

#### Participants.

##### Age

20~29

##### Number

20 people (10 couples)

##### Department

UNIST students

##### Condition

Who has Instagram account with more than 20 photos since before May, 2019

ID	gender	Number of photos	Latest uploaded photo date (until the experiment time)	uploaded photo date (until the experiment t	Age
1	남	23	2019.10.25	2016.02.22	24
2	남	64	2019.11.08	2017.12.28	25
3	여	33	2019.11.10	2018.02.06	23
4	여	51	2019.11.08	2019.04.04	24
5	남	41	2019.11.08	2018.03.31	24
6	남	27	2019.09.12	2017.03.30	24
7	남	48	2019.11.01	2018.02.16	23
8	여	137	2018.09.02	2019.11.05	21
9	남	25	2017.7.23	2017.1.21	24
10	남	70	2019.09.23	2015.10.31	24
11	남	117	2019.11.12	2017.02.18	26
12	여	64	2019.11.4	2018.9.8	24
13	여	21	2019.10.31	2019.02.15	23
14	여	142	2019.11.12	2014.07.23	23
15	여	39	2019.10.23	2018.11.16	24
16	여	84	2019.11.16	2018.11.03	20
17	여	33	2019.11.10	2018.02.06	26
18	남	466	2019.11.14	2015.01.29	26
19	여	449	2019.10.05	2014.03.31	26
20	남	570	2019.08.05	2017.7.17	29

Figure 29. Overview of Participants

### Methodology

An in-lab study was conducted by Wizard of OZ (Martin B. et al, 2012) method to test our product before development has begun (Crook N., 2018). In SLOWPIXELS, small Bluetooth-enabled thermoelectric printer (Figure 30) was connected through application. If users chose the time and distance condition of the picture by each slider, we, practitioner – the ‘Wizard’ - controlled responses sent to the user via printer (Crook N., 2018). After users printed out their partner’s photo, each partner has to tell their story regarding to picture. It aims to stimulate them to reflect their past. Then, they were asked to their opinion regarding SLOWPIXELS to compare the retrieval process of smartphone and SLOWPIXELS (Figure 31).

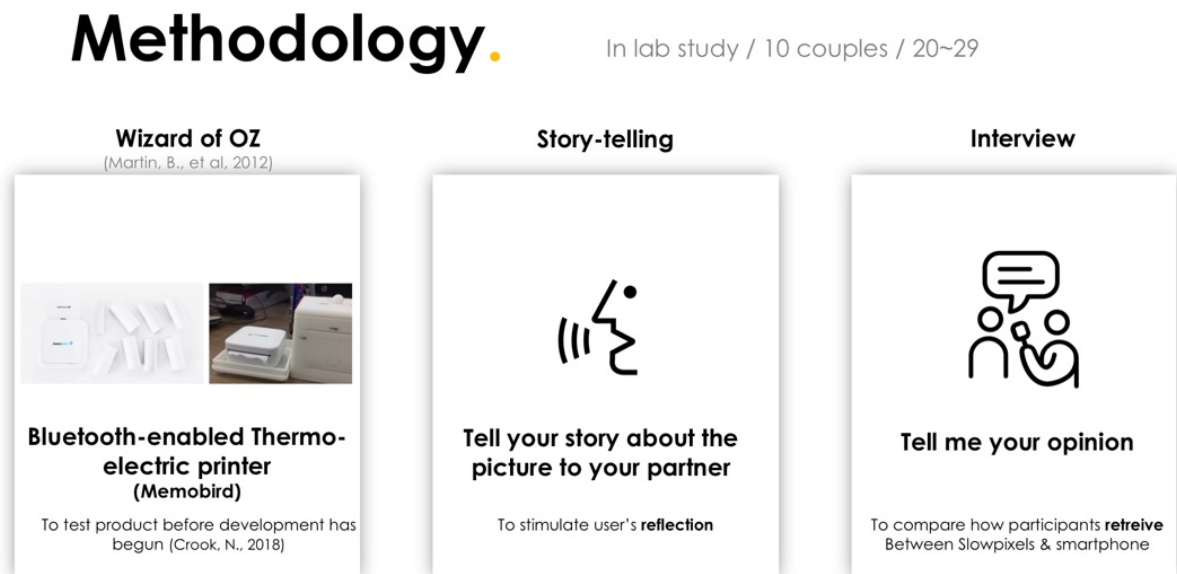


Figure 30. Methodology



Figure 31. Interview

## Procedure

# Procedure.

In lab study / 10 couples / 20~29

**Time**  
30 min

**Date**  
11 days (2019.11.11~21)

**Place**  
UNIST Engineering building 104-904  
(in-lab study)

### Experiment



(15 min)

1. Play with Slowpixels.
2. Chat with your partner.
3. Same with your partner.

### Interview



(15min)

1. Tell me your experience.
2. What's the big difference bt phone & Slowpixels?
3. How did you feel if you print the unexpected photo?
4. In what context will it be used (alone or friends)?



Figure 32. Procedure of user study

We conducted user study with SLOWPIXELS in a meeting room for 11 days. All experiments were video recorded. The experiment was conducted through the following procedures: First, each

participant browsed their partner's Instagram photo. First, they browsed the photo date and distance using sliders, then printed the picture by pressing the button on the top. Then, partner repeated the same process. If they want, continue the same process. During the experiment, participants should tell their story regarding to the picture to their partner for 15 minutes (Figure 32). Finally, each interview lasted approximately 15 minutes (Figure 32). Therefore, the total amount of time for each experiment lasted for about 30 minutes. All answers were recorded. Interview sessions were all open-ended discussions about their experience with SLOWPIXELS, but we also asked about the following questions during discussions.

- What's the big difference between smartphone and SLOWPIXELS while using?
- How did you feel if the picture you printed was different from the one you expected?
- In what context will SLOWPIXELS be used (alone or more than two people)?

#### *Conditions of Pictures*

For Wizard of OZ method, we collected and saved the participants' photos previously from their Instagram account. During the user study, if users choose the time and distance condition of the picture by slider and lever, we send images from our Smartphone application to printer right away by Bluetooth. The photo date was based on the uploaded time of each picture and the location was based on the Instagram place tag. In summary, the photo conditions are:

- (1) Photos were provided from each participant's Instagram account.
- (2) The number of photos should be more than the twenties in their account and the oldest photo should be uploaded after 6 months ago. Also, more than twenties photos should have 'location' information.
- (3) The reference points for the time and location were the time and place at which the participant conducts the experiment. In this study, the time was from 11st to 21st of November in 2019, and the place was the longitude and latitude of authors' home education institution. (35°34'20.6"N 129°11'25.7"E).
- (4) How 'near' or 'far' or 'old' or 'new' are different by each participant's photographs.



### 4.3 Analysis

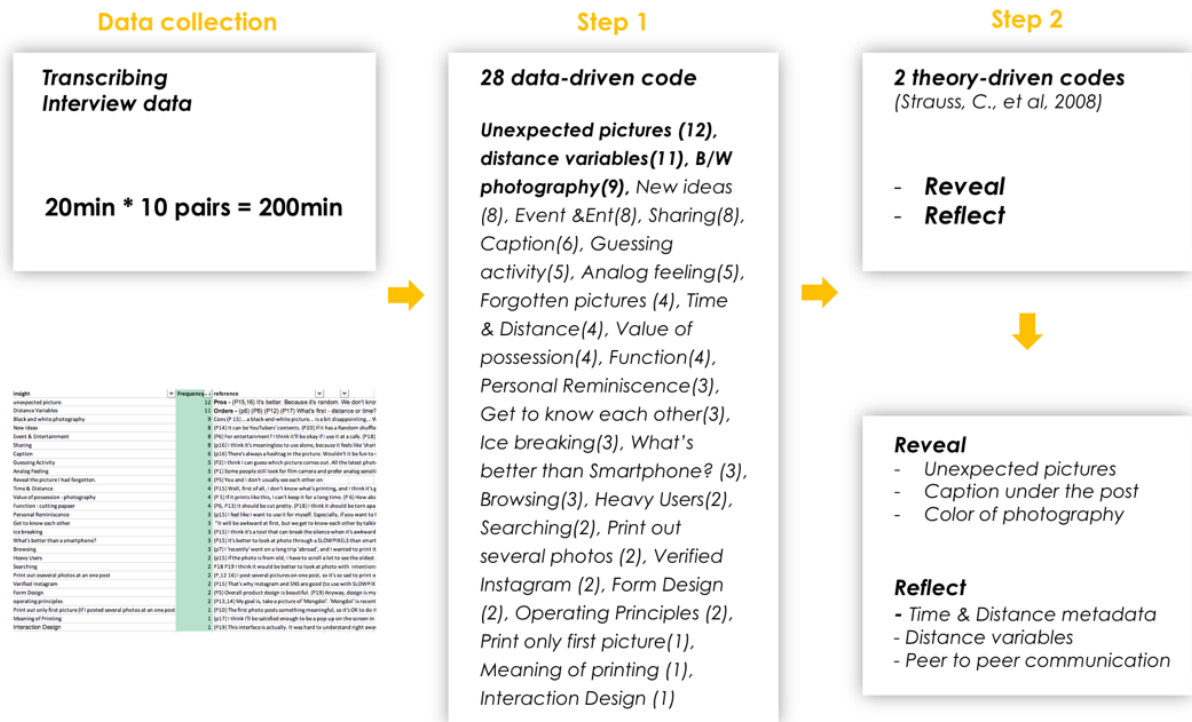


Figure 33. Analysis of Interview data

For analysis, we transcribed all interview recordings, in order to analyze the quantitative data. Then, we encoded and analyzed the interview data (Figure 33). First, we created the data-driven codes. We gathered the similar answers from raw data, then created 18 codes based on these answers. Second, we generated two theory-driven categories, Reflect & Reveal according to the Slow Design Principles (Strauss, C., et al., 2008, p.3~7). We reviewed and revised these codes in the context of data (Figure 34).

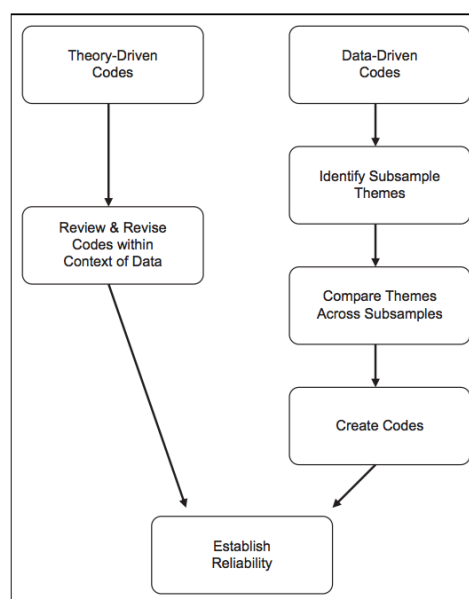


Figure 34. Steps for developing a codebook (DeCuir-Gunby, J. T. et al, 2011)

#### 4.4 Findings

The table below shows three most mentioned codes among 28 codes, grouped by similar answers based on interview data. The whole codes, definitions, and examples were on the appendix 2. (Table 3)

Table 3. Data-driven codes, description, and examples

<u>Data-driven codes (frequency)</u>	<u>Description</u>	<u>Example</u>
<b>Unexpected Picture (12)</b>	Unexpected picture is fun & exciting.	“It was fun because there was a picture that I never thought of.” (P11, 12, 15, 16)
<b>Distance Variables (11)</b>	The relationship between distance data and reflection on photography	“Time is important when recalling memories, but the distance is not. Rather than distance, (I prefer) mood (feeling) or time” (P19, 20)
<b>B/W photography (9)</b>	Black-and-white photography is disappointing.	“...A black-and-white picture... is a bit disappointing... When I first saw this, I cannot recognize what is it...” (P15)

Below table was about two theory- driven codes form Slow Design Principles (Reflect & Reveal). There were also three subcategories in each code. (Table 4)

Table 4. Theory-driven Codes, Description, and examples

<u>Theory-driven Codes (frequency)</u>	<u>Description</u>	<u>Example</u>
<b>Reveal (27)</b>	Slow design reveals experiences in everyday life that are often missed or forgotten, including the materials and process that can be easily overlooked in an artifact’s existence or creation.	
<b>Unexpected Pictures (12)</b>	Surprising pictures reveals forgotten memories	“It was fun because there was a picture that I never thought of.” (P11, P12, P15, P16)
<b>The caption (6)</b>	The caption of photography reveals the memory of Instagram post	“I’d like you to let me know when I posted this picture. When and where I filmed it. I hope the information about the pictures will come out as a result.” (P6)
<b>The color (9)</b>	The color of photography reveals the vivid memory	“I prefer color photo. If possible. It’s more lively. It can give me more vivid memories...” (P5)



<b>Reflect (31)</b>	Slowly-designed artifacts/environments/experiences induce contemplation and what slowLab has coined 'reflective consumption'.	
<b>Time &amp; distance metadata (4)</b>	Retrieving digital photography using time & distance metadata induce reflection	"Definitely, I can think more about how old they (pictures) are, while I'm thinking about the time and place of photo." (P5)
<b>Distance variables (13)</b>	The relationship between distance variables and reflection on photography	"Time is important when recalling memories, but the distance is not. Rather than distance, (I prefer) mood (feeling) or time" (P19,20)
<b>Peer to Peer Communication (14)</b>	Peer to peer communication encourages reflection on themselves	"I think it's good to watch and share photos with friends. Because there's time to print and wait." (P2)

#### 4.4.1 Reveal

In this slow design principle, design could reveal experiences in everyday life that are often missed or forgotten including the materials and process that can be overlooked (Carolyn F, Strauss and Alastair Fuad-Luke, 2008).

##### *Unexpected pictures reveal forgotten memories*

We tried to reveal the forgotten photos in the user's digital photo archives through unexpected photo printing. We found that SLOWPIXELS reveal forgotten photos & memories in the user's personal digital photo archives. 50% of the participants felt excited or embarrassed when their partner printed unexpected pictures of their Instagram. (P1, P2, P6, P7, P11, P12, P14, P15, P16, P17). At first, most of them expected specific photos when their partner tried to print their photos. However, when printed pictures were different from the ones they expected, expectations turned into surprise. There were conflicting reactions from person to person. 40% of subjects described that it was fun and exciting when they printed out unexpected or forgotten photos from their or their partner's Instagram. Because both of them cannot guess exactly which pictures come out.

- "It's good to share a photo that I forgot even I uploaded." (P2)
- "It was fun because there was a picture that I never thought of." (P11, P12, P15, P16)
- "Because I don't know what I'm going to get, I was so excited. When it came out, I thought of my feelings and experiences. It was better. We don't have a chance to show each other on

Instagram. I think it's a different experience to talk about our experiences when we both don't know what you're going to see." (P7)

Participant 6 & 17 replied that it doesn't matter even they printed out the unintended picture, because they thought the purpose of SLOWPIXELS are not finding the exact photo.

- "We did not intend to search the 'right' picture at the 'right' time. So, I think it is not a big problem, if it prints randomly. Because SLOWPIXELS can recall your memories, even if it's not what you want." (P6)
- "In fact, if you're looking for a picture that you really want, you should just look it up on your smartphone. Even if I don't get what I want, it's fun..." (P17)

However, two people (P1, P14) showed negative feeling about the unexpected picture.

- "Some people might be embarrassed by the unexpected pictures. Because Instagram is also private place" (P1)
- "I'm so sad that I can't pick the pictures which I want..." (P14)

*The caption of photography reveals the memory of Instagram post*

We found that the caption of Instagram post plays an important role when people reflect their past. To be honest, we overlooked and didn't expect the role of the caption under the photo in Instagram before user study. However, six participants said that if captions they posted on Instagram were printed together, it would be more helpful for their memory recall. (P5, P6, P10, P16, P19, P20)

- "If it (SLOWPIXELS) is based on Instagram, it'd be great if I could get the text that I wrote down." (P5, P19, P20)
- "I want it to let me know as a result when and where I posted this picture. I hope the information about the pictures will come out as a result." (P6)
- "I printed it out, but I don't know what I was doing (in this picture). However, I think I'll know if it gives me an information." (P20)

Participant 16 suggested a hashtag.

- "There's always a hashtag in the picture. Wouldn't it be fun to print hashtags with photos for sharing?" (P16)

Participant 10 also said that if two people who don't know each other use the product together, this opportunity will allow them to be Instagram friends. This is a discovery that shows the social utility of SLOWPIXELS.

- “It would be nice to see the article below. Just like an Instagram, showed my ID, friend can follow each other’s account by taking this paper...” (P10)

#### *The color of photography reveals the vivid memory*

We confirmed that the color of photography also plays an important role when people recall their memory. We used black-and-white photography on thermo paper for easy manipulation & reflection. We assumed that b/w photography makes people more think about their picture, because it is hard to recognize the contents. 35% of participants said that color is important to recall their memory (P 2, 5, 9,15,17,18, 20).

- “...A black-and-white picture... is a bit disappointing... When I first saw this, I cannot recognize what is it...” (P 15)
- “I prefer color photo. If possible. It’s more lively. It can give me more vivid memories. It was snowy photo, but it’s black and white, so honestly...(disappointing). It’s a nice picture because it snowed.” (P 5)
- “I think I can guess what the picture is, if the picture is colored. (P 18) I’d know if there were any colors...” (P 17)
- “Some pictures are black and white, so it’s hard to recognize without any distinctive features. I’m confused because there’s no color.” (P 2)
- “It’s too bad, because it’s not a color.” (P 9, P10)
- “I’d prefer a color.” (P 20)

However, one participant (P10) commented that black and white photography was more interesting.

- “If it’s a color photo, it’s not fun, because I can recognize what it is. It’s fun if it’s black and white, because I can guess.” (P10)

#### 4.4.2 Reflect

In this theme, slowly designed artifacts/environments/experiences enable people to induce contemplation and reflective consumption (Carolyn F, Strauss and Alastair Fuad-Luke, 2008). We utilized physical interaction without displays to make people reflect about their digital photo archives while retrieving digital photography.

#### *Retrieving digital photography using time & distance metadata induce reflection*

We found that retrieving the photos according to time & distance enables some participants to reflect and recall their memory. 20% of participants replied that it helps their reflection (P5, P6, P9, P15). Because they have to select the time or distance zone to print the picture.

- “Definitely, I can think more about how old they (pictures) are, while I’m thinking about the time and place of photo.” (P5)
- “Usually when I look at a picture (using smartphone), I pass it by without thinking deeply. But when I use SLOWPIXELS to view pictures, I have to think. So, it makes me think more about the situation where the photo was taken.” (P6)
- “I lived without thinking about the past, but it gives a time to think about it.” (P9)
- Well, first of all, I don't know what's printing, and I think it's great to recall my memory. “Oh, this one's. That's right.” like this. It's like how I look back at the past with my diary. (P 15)

However, participant 19 mentioned that she has difficulty to understand the interface design.

- “This interface is actually. It was hard to understand right away. I don't care if I don't have to understand right away. Time moves backwards so the slider moves left. But in case of distance... even if it goes far, the slider goes up. What is it? But at that time, the light came in and I could understand it.” (P 19)

This issue will be mentioned on the discussion part.

#### *The relationship between distance variables and reflection on photography*

We used both time & distance metadata, because we predicted both elements could support people to reflect while retrieving digital photography. However, 30 % of participants raised the questions about distance variables. (P5, P8, P18, P19, P20) We will discuss this issue in the next chapter. Participant 5 & 8 also mentioned that the combination of these two variables is too complicated to predict the picture. Two participants (P19, 20) said that ‘distance’ is not important for memory recall when they recall their memory thorough photography. P 18 said similar opinion, because she doesn’t go travel often.

- “In fact, I'm not so curious about distance (because I don't go travel often).” (P18)
- “Time is important when recalling memories, but the distance is not.” (P19, P20)
- “I think it's hard to predict (pictures), because I have two variables in common.” (P8)
- “Something complicated. Because It feels like an intersection of time and space... I thought 'Kotakinabalu' would come out. But there's something else.” (P5)

Participant 20 dissatisfied with the ambiguous criteria.

- “Criteria for time & distance are ambiguous (=relative, subjective).” (P20)

20% of participants wondered which variables were considered first when choosing a picture. Even one participant (P18) suggested the new option.

- “What's first - distance or time?” (P6, P8, P12, P17)

- “I think it (=photo printing) can be changed in order. I think it would be good if I could choose an option. (Because) users may want to see (photo) by distance within a certain time frame, or see photo by time (within a certain location).” (P18)

*Peer to peer communication encourages reflection on themselves*

After printing their partner’s photos, they have to listen to the story about each photo from partner. During storytelling, it encouraged them to think about their past & their partner’s life. Participants also mentioned that SLOWPIXELS provides a topic of conversation. Participant 5&6 added that they were very close, but they don’t usually watch each other’s Instagram. However, they have become to know each other’s life more than before while using SLOWPIXELS.

- “You and I don't usually watch each other's Instagram. We don't have to look for each other, but it's not bad (to watch each other's photo).” (P5) “I didn't know you went to England.” (P6)

Participant 10 noted that it would be great if two strangers can use SLOWPIXELS to get to know each other. Because it provides opportunity to talk each other. Participant 14 & 15 also said similarly.

- “I think it would be fun to do this when two people are getting to know each other for talking purposes.” (P10)
- “... I think it's good to talk about it. It's good to talk about what we've done in the past when we've got nothing to do.” (P14)
- “It will be awkward at first, but we get to know each other by talking to each other while looking at pictures. It's fun to know about her because she can talk about herself as the paper comes out. I think it's a tool that can break the silence when it's awkward.” (P15)

## 5

### Discussion

In this chapter, we proposed the following design implications derived from user study findings for reflective retrieval of personal photos or other related design research fields.

#### 5.1 Discussion

##### 5.1.1 Designing for revisiting serendipitous memories on the past (Reveal)

Due to the dematerialization of digital contents, it makes people can hardly grasp how big their archives are. However, participants can realize that they have forgotten or missed numerous photos when they used SLOWPIXELS. We discovered that 50% of participants addressed that unexpected pictures ‘revealed’ their forgotten memories in their digital photo archives (P1, P2, P6, P7, P11, P12, P14, P15, P16, P17). 40% of participants can also experience the serendipity when they find unexpected photos. (P2, P6, P7, P11, P12, P15, P16, P17) In results, SLOWPIXELS has a potential in the public space for event-like situation. 40% of participants mentioned that SLOWPIXELS can be used for event or entertainment use (P1, P6, P9, P11, P12, P13, P14, P18).

- (P6) I think it'll be okay if I use it at a cafe. (P6, 18) It can be used for entertainment. (P11, 12) It feels like a guessing game. (P1, P14) It feels like it is for event. (P9) It is for playing together. (P13) I think it's not for daily use.

In summary, these findings suggested new opportunities for Slow-design which reveals forgotten memories and revisits the serendipity from the past.

##### 5.1.2 Designing for empowering social communication

It was a rather interesting outcome that the participants agreed that it was more suitable for use by multiple people. Because the initial objective of this paper was to identify how SLOWPIXELS supports personal reminiscence in every-day life. Interestingly, 25% of participants said that this product provides an opportunity for the participants to talk to each other (P5, P6, P10, P14, P15). 25% of participants also addressed that it is for where many people can use such as café (P5, P9, P10, P15, P18).

- (P15) That sounds interesting. I can put them in the community room... (P5) Don't leave it at home. Or you can just leave it at the café.. (P18) I think it'll be fun to use in a group. (P9, P10) Let's have coffee and talk with it in a cafe. It would be fun to do it with a friend.

In summary, these findings suggested new opportunities for Slow-design which enables users to be collaborate and empowers social communication.

#### 5.1.3 Relationship between time, distance metadata & reflection in retrieving digital photography

We found that 20% of participants can reflectively retrieve their personal photos while exploring time & distance metadata through physical interaction (P5, P6, P9, P15). However, it is important to note that this study has been unable to demonstrate clearly that 'distance' variable is crucial for reflection in photography. Twenty-five percent of the participants were skeptical about the distance variables (P5, P8, P18, P19, P20).

Instead, 'caption' was found to play an important role in reflection. As more than 30% of participants confirmed, caption or hashtags under the Instagram posts reveal the memory of Instagram post (P5, P6, P10, P16, P19, P20). 'Color' of photography was also important (P5, P6, P10, P16, P19, P20).

## 5.2 Limitations

### 5.2.1 Implementation & Development

First, the number of pictures was limited to only 4 pictures for each participant. Because, we prepared only extreme conditions of pictures for easy manipulation in the context of Wizard of Oz method. For examples, 'Oldest – Nearest', 'Oldest-Farthest', 'Newest-Nearest', and 'Newest-Farthest' picture. It caused problems when the participant chose the 'middle' range of time or distance. Because of that, people sometimes surprized or disappointed. Second, we overlooked the order of the criteria for selecting pictures: Time and Distance. We selected the user's photo according to time first and then, distance. However, one participant (P18) suggested the possibility of difference when we change the order. He argued that the printed pictures would be different if they are in different two orders: time-distance or distance-time.

### 5.2.2 Interaction Design for distance variables

We used two physical interaction for retrieving time and distance variables in this study. However, one participant (P19) criticized that the pulling up interaction of distance lever is somewhat difficult to understand. She mentioned that LED helps to understand, but we should consider another intuitive and

affordable interaction for distance lever. Also, 30% of participants raised questions about the distance variables (P5,8,18,19,20), because it was complicated to use.

#### 5.2.3 Reliability issue

It was necessary to use multiple coders to analyse interview data for establishing reliability in analysis of study. However, in this study, translation and analysis were conducted by one person, so there was a limitation in reliability.



## Conclusion

### Summary and Contribution

We designed SLOWPIXELS to investigate how Slow-design supports reflection in retrieving personal photography. Findings revealed that SLOWPIXELS encourage users to reflect their past by unexpected pictures and promote their social bond. Finally, we also found that SLOWPIXELS has a design possibility in the public space for event-like situation. For example, in café or student community centre. Based on the findings, we suggested new design implications for revisiting serendipitous memories on the past, empowering social communication and exploring the slow-design agenda within the Design Research community.

### Further Study

In the future, we will complete the development of SLOWPIXELS. Although we have already made the printer module and tried to develop with Raspberry Pi and python software, we used Wizard of Oz method in our user study due to the lack of time. After development completed, we can increase the number of pictures in the next experiment. Second, we should consider more about the distance variables. Because of complication problem, 6 participants criticized about the combination of time & distance. We should think about more simplified interaction design. Lastly, we should find other features to support user's reflection in retrieving photography such as caption (e.g. mood, hashtag, date, and etc) under the picture.

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## Appendices

### Appendix I. Demographic data

<u>ID</u>	<u>gender</u>	<u>Number of uploaded photos</u>	<u>Latest uploaded photo date</u> <u>(until the experiment time)</u>	<u>First uploaded photo date</u> <u>(until the experiment time)</u>	<u>Age</u>
1	Male	23	2019.10.25	2016.02.22	24
2	Male	64	2019.11.08	2017.12.28	25
3	Female	33	2019.11.10	2018.02.06	23
4	Female	51	2019.11.08	2019.04.04	24
5	Male	41	2019.11.08	2018.03.31	24
6	Male	27	2019.09.12	2017.03.30	24
7	Male	48	2019.11.01	2018.02.16	23
8	Female	137	2019.11.05	2018.09.02	21
9	Male	25	2017.7.23	2017.1.21	24
10	Male	70	2019.09.23	2015.10.31	24
11	Male	117	2019.11.12	2017.02.18	26
12	Female	64	2019.11.4	2018.09.08	24
13	Female	21	2019.10.31	2019.02.15	23
14	Female	142	2019.11.12	2014.07.23	23
15	Female	39	2019.10.23	2018.11.16	24
16	Female	84	2019.11.16	2018.11.03	20
17	Female	33	2019.11.10	2018.02.06	26
18	Male	466	2019.11.14	2015.01.29	26
19	Female	449	2019.10.05	2014.03.31	26
20	Male	570	2019.08.05	2017.7.17	29

## Appendix II. Data-driven codes

<u>Insight</u>	<u>Participants</u>	<u>Frequency</u>
unexpected picture	1,14, 2, 6, 7,11, 12, 15, 16, 17	12
Distance Variables	6,8,12,17,18,5,19,20,3,4,10	11
Black and white photography	2, 5, 9,15,17,18, 20, 10	9
New Ideas	9,10,11,12,13,14,19,20	8
Event & Entertainment	1,6,9,11,12,13,14,18	8
Sharing	1,2,5,8,10,13,16,18	8
Caption	5, 6, 10, 16, 19, 20	6
Guessing Activity	1,2,15,16,20	5
Analog Feeling	1,9,10,11,12	5
Reveal the picture I had forgotten.	1,2,5,6	4
Time & Distance	5, 6, 9, 15	4
Value of possession - photography	5,6,19,20	4
Function : cutting papaer	2,6,13,18	4
Personal Reminiscence	15,19,20	3
Get to know each other	5,6,10	3
ice breaking	10,14,15	3
What's better than a smartphone?	9,10,15	3
Browsing	7,11,17,18	3
Heavy Users	11,15	2
Searching	18,19	2
Print out oseveral photos at an one post	12,16	2
Using Instagram photo is verified(?)	5,15	2
Form Design	5,19	2
Thinking about the operating principles	13,14	2
Print out only first picture (If I posted several photos at an one post)	10	1
Why do I have to 'print' out?	17	1
Interaction Design	19	1

### Appendix III. Theory-driven codes

Category		Insight	Participants	Frequency
		Heavy Users	11,15	2
		New Ideas	9,10,11,12,13,14,19,20	8
		Event & Entertainment	1,6,9,11,12,13,14,18	8
		Personal Reminiscence	15,19,20	3
Reflect		Sharing	1,2,5,8,10,13,16,18	8
Reflect	Peer to Peer communication	Get to know each other	5,6,10	3
Reflect		ice breaking	10,14,15	3
Reveal	Surprising pictures	unexpected picture	1,14, 2, 6, 7,11, 12, 15, 16, 17	12
Reveal		Reveal the picture I had forgotten.	1,2,5,6	4
Reflect	Physical Interaction	Time & Distance	5, 6, 9, 15	4
		What's better than a smartphone?	9,10,15	3
Reflect	Distance Variables	Distance Variables	6, 8, 12, 17, 18, 5, 19, 20, 3 ,4, 10	11
		Browsing	7, 11, 17, 18	4
		Searching	18,19	2
		Print out several photos at an one post	12,16	2
		Print out only first picture (If I posted several photos at an one post)	10	1
		Using Instagram photo is verified(?)	5,15	2
		Value of possession - photography	5,6,19,20	4
		Why do I have to 'print' out?	17	1
Reveal	Color	Black and white photography	2, 5, 9,15,17,18, 20, 10	9
		Function: cutting paper	2,6,13,18	4
Reveal	Caption	Caption	5, 6, 10, 16, 19, 20	6
		Form Design	5,19	2
		Thinking about the operating principles	13,14	2
		Guessing Activity	1,2,15,16,20	5
		Analog Feeling	1,9,10,11,12	5
	Physical Interaction	Interaction Design	19	1