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# Investigating the Change through Physical Representation of Self-reflective Data : Field Study of Bookly and Further Implication

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Investigating the Change through Physical  
Representation of Self-reflective Data  
: Field Study of Bookly and Further Implication

A thesis submitted  
to the Graduate School of Creative Design Engineering, UNIST  
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requirements for the degree of  
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06.20.2020

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Investigating the Change through Physical  
Representation of Self-reflective Data  
: Field Study of Bookly and Further Implication

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06. 20. 2020

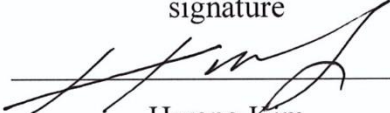
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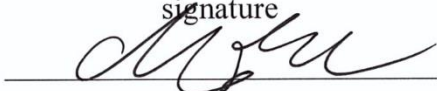
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## Executive Summary

Through the development of everyday things, technologies and data are naturally being embedded and shown in our surroundings. Closely interacting with these data can directly affect us in various ways. Recent research has suggested engaging with self-related data in everyday life could support self-reflection, increase awareness of their behavior and encourage consistency. We wanted to bring these backgrounds to deal with the behaviors which has weak motivation and chose reading activity to be our target. We designed Bookly, an interactive artifact that physically represents the accumulated time of users' reading activity through abstract volumetric changes. Bookly accumulates the time of reading related actions (e.g., picking up and putting down books) and provides a designated space for a book which is on-going. The results of our 2-week in-field study with six participants showed that continuous exposure through volumetric movement representing the accumulated time of reading helped the users to recognize and understand their unsettled patterns of reading. Bookly also motivated the users to improve their reading behavior by gradually making reading to be part of their schedules. Additionally, the definite designation of the ongoing book improved its visual affordance and accessibility for the users to grab the book and start reading. Based on the findings, we confirmed the possibility of making intangible goal related data in physical expression for self-reflection to enhance changes in behaviors that are difficult to perform due to weak motivation. We would like to suggest further implication and its expected contribution by expanding the weak motivated reading activity to any kinds of one-off plans that was unfulfilled due to the same reason.

Keywords: Data Physicalization, Self-Reflection, Reading motivation, Book

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## Chapter 1

# Introduction

### 1.1 BACKGROUND

The development of everyday things has naturally embedded and shown desired technologies and data in our surroundings. Personal meta-data are presented in the forms of everyday things and by closely interacting with these data can deliver extended value (Willet & Weibel, 2018; William Odom et al., 2018, 2019). In recent research has suggested engaging with self-related data in everyday life could support self-reflection, increase awareness of their data and behavior patterns, and induce engagement with the data (Prochaska & Norcross, 1992; Thudt et al., 2018). Putting this on our background we wanted to apply this with the activities that one desires to do but unfulfilled due to the weak motivation. Such actives could be watching less TV, reading more books, eating healthy food, exercise more often, or could be one-off plans such as drink coffee with old friend, watch a movie with parents and so on. We wanted to explore the relation between the behavior change and the experience of physically representing the data that is related with these kinds of activity in everyday life.

We narrowed down to reading which is a well-known activity that can help people in various ways. Reading can provide mental stability, knowledge acquisition and linguistic-skill development (Cunningham, A. & Stanovich, K., 1998). However, incorporate reading into daily routines is not easy for everyone. To make the needs easier to reach action, keep reminding their motivation to read is important. Based on the previous literature, to motivate people to read books, building a family atmosphere (Baker, L et al., 1997; Raffle, H. et al., 2011), goal-setting methods (Cabral-Márquez, C., 2015) and provoking interests by delivering contents of books through diverse digital mediums (Jansen, Y., 2015; Mori, K et al., 2011; Zhao, Y. et al., 2014) are proposed. In previous HCI (Human Computer Interaction) studies have suggested ways to induce reading by reading companion robot (Michaelis, J. E. & Mutlu, B., 2017), utilizing a tangible book game (Linke, R et al., 2017) and story-related haptic feedback device (Yannier, N et al., 2015). They showed how those devices could drive enhancement in reading interest to people especially who have weak reading motivation. However, methods that help users to continuously perceive their individual reading state, which is the basic method in inducing people in the preparation stage to move toward the action stage (Consolvo, S et al., 2009; Prochaska, J. et al., 1992), have rarely been studied.

At this point we need to understand the advantages of paper book's physical properties. Physicality of a paper book can provide a continuous reminder of the book's existence to people in its environment

(Gruning, J., 2018) and can deliver message of the individual's reading state with its storage form and place (Hupfeld, A., & Rodden, T., 2014; Rouncefield, M., & Tolmie, P., 2011). In this regard, a former study (Rouncefield, M., & Tolmie, P., 2011) revealed that the storage method and location at home were directly connected to its topology, that is, as messages containing its reading state. For instance, divided ratio by a bookmark could shows reading progress, or a book that is flipped open and placed upside down on the bedside table could express that the book is currently being read. In other words, the physicality of books that may inform the personal reading state, could influence the reading motivation and induce the continuity of reading.

At this point we need to take a closer look at the advantages of paper books' physical characteristics. Physicality of paper book can work as continuous but quiet reminder of its existence when people are around paper book (Gruning, J., 2018) and can provide a message about reading state with the stored form (Hupfeld, A., & Rodden, T., 2014; Rouncefield, M., & Tolmie, P., 2011). A former study (Rouncefield, M., & Tolmie, P., 2011) showed that the certain book's storage method and location at home were directly linked to its topology, in other words, it works as messages informing the state of reading. For example, a bookmark could show the progress of reading in amount of divided ratio, or a flip opened book which is placed upside down on the bedside table can tell that the book is currently paused to read but will proceed. That is, paper books' physicality, quietly interacting to deliver the information of progress, can be used to motivate reading by its topological message.

In response to these issues, previous HCI studies have suggested tangible devices that offers book's contents while reading by combining the functionality of digital books and the materiality of paper books. Through adding AR markers printed on book pages (Michaelis, J. E. & Mutlu, B., 2017), the Mixed Reality Book that connects the inside and surroundings of the book (Grasset, R et al., 2007), and the Magic Story Cube (Zhou, Z. et al., 2004), they promoted interest and engagement in reading by partially preserving the physicality of books. However, above studies have mainly focused on enhancing readability or effectively delivering contents but the ways of naturally delivering each progress of reading to provide self-reflection in our everyday lives have not been considered.

In this, we could find several approaches that provided self-reflection through tracking certain activity and visualizing the collected data to manage the continuity of behavior (Thomaz, E et al., 2015; Erik Hekler et al., 2013; Vaizman, Y. et al., 2018). Moreover, Thudt et al. research team showed effectiveness of physicalizing the personal data by designing a self-reflecting tool (Thudt, A. et al., 2018). However, physicalizing data that is related to daily reading behavior (e.g., putting down and picking up the book) and the value of naturally exposing it around the everyday context have not been investigated.

## 1.2 DESIGN GOAL & RESEARCH METHODOLOGY

Building upon the existing research, we were able to identify the need to not only amplifying the materiality of the paper book, but also to seek ways to store the ongoing book and to deliver self-reflecting data that shows overall reading process in everyday life. In this research, our target was set as busy young adults who have performed preparing actions such as borrowing or buying books they want to read (essays, novels, or academic books) but often failed to picking it out from the bookshelf and start reading them. We decided to provide reading motivation for the people who are in the preparation stage of the Transtheoretical Model's 5 stages of behavior change, which starts from pre-contemplation stage, contemplation stage, preparation stage, action stage, and at last maintenance stage (Prochaska, J. et al., 1992). This model suggests, for those who are in the preparation stage, increasing awareness of their status through a persuasive technology can be a way get them near to the action stage. Thus, this study's goal was to make a technology-embedded design intervention that would play a role in encourage users to reach reading action. Therefore, we designed an interactive everyday tangible artifact, called Bookly (Figure. 1), and discovered how it affects users' reading habits in their daily environment.



**Figure 1 A book that is waiting to be picked up on Bookly.**

## Chapter 2

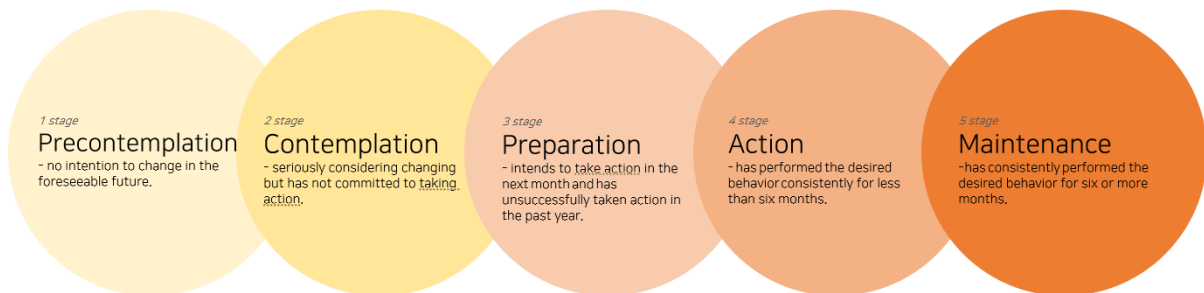
# Related Work

### 2.1 BEHAVIOR CHANGE

#### The Transtheoretical Model

The main target for our research is ones who has weak motivation. These targets' characteristic can be explained with the Transtheoretical Model that Prochaska et al's research team suggested. This model describes the 5 stages (Figure. 2) through which an individual progress to intentionally modify addictive or other problematic behaviors. Each stage's descriptions are as followed:

- ✓ **Stage 1. Precontemplation stage** - no intention to change in the near future.
- ✓ **Stage 2. Contemplation stage** - seriously considering to change but has not committed to take any action.
- ✓ **Stage 3. Preparation stage** – intends to take action in the next month and has unsuccessfully taken action in the past year.
- ✓ **Stage 4. Action** – has performed the desired behavior consistently in few months.
- ✓ **Stage 5. Maintenance** – has consistently performed the desired behavior for six or more months.



**Figure 2 the Transtheoretical Model by Prochaska and Norcross.**

Our target is the ones who are in preparation stage, which they intend to take action in the next month and have unsuccessfully taken action in the past year. In specific, people who prepared to read by buying or barrowing the book but not succeeded to read until the last page of the book or even start the book. To induce people in stage three to move to stage 4, this model suggests that for those who have weak motivation focusing on increasing awareness of their own behavior patterns will encourage consistency.



## Behavior Economics

Behavioral economics (Mullainathan, S., & Thaler, R. H., 2000) is study of incorporating psychology into the analysis of the decision-making behind an economic outcome. It combines insight of psychology, judgment, and decision making, and economics to generate a more accurate understanding of human behavior. This relates with the term nudge that Thaler and Sunstein addressed (Thaler, R. A., & Sunstein, C. R., 2017). Under the assumption that people are not so rational when making decisions, nudge theory shows how subtle changes can have a profound influence on the way people behave without any direct enforcement that can used to improve the life and wellbeing of people and society. By designing choice environments that can easily alter people’s behavior and decisions without directly forbidding any rules or forcing to choose what is best for themselves, their families, and society. Thaler and Sunstein shows how thoughtful "choice architecture" can be established to nudge people in beneficial directions without disturbing freedom of choice. It can be also described as “non-enforced compliance”. Choice architects and policy makers aim to change people’s behavior and alter their decisions more effectively through nudge rather than relying on regulations or direct enforcement.

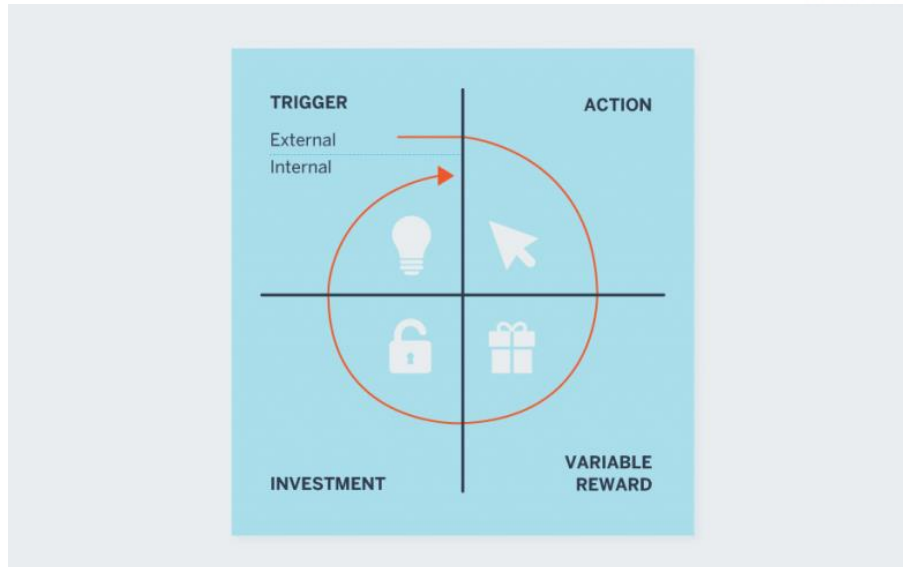
Through nudging with consistently exposing the data that relates with user’s previous will and progress in their environment, message can be delivered without directly forcing or make users feel their freedom is invaded.

## Habit Forming

In market area, many companies consider habit forming to turn their products into habits to drive a lot of values. From the point when product becomes a habit, it does not require extensive advertising to ensure usage. Additionally, it is more linked to users’ emotions and routines. Hooks (Eyal, N., 2014) are a series of experiences that can modify user behavior and encourage formation of new habits. Increasing accessibility to more data and improving the speed of data delivery can raise hooks to drive one’s habit formation. The 4 phases of the Hook Model are followed: (Figure. 3)

- ✓ **Trigger.** External or internal cues or the foundation for prompt certain behavior
- ✓ **Action.** Use of the product, based on motivation and ease of use
- ✓ **Variable Reward.** The reason for product use, which keeps the user engaged
- ✓ **Investment.** A useful input from the user that commits him to go through the cycle again

In trigger phase, there are extrinsic and intrinsic trigger types (Figure. 4). Extrinsic triggers are the parts of information from users’ surroundings that change them to perform an action. Intrinsic triggers are driven by the users’ emotions and associations stored in their memory. For a trigger to be effective, the

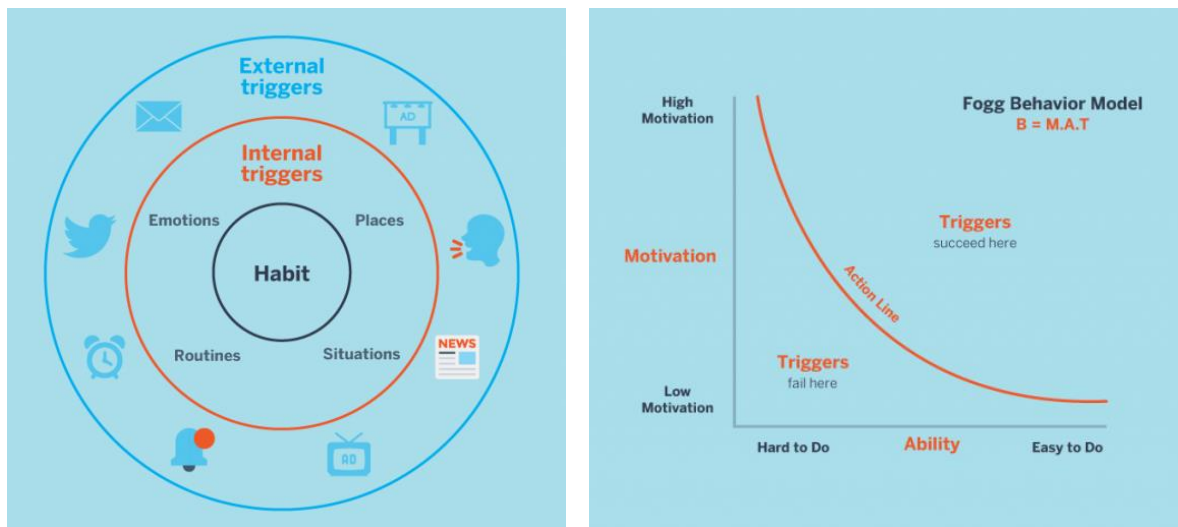


**Figure 3 the four phases of the Hook Model**

users must be sufficiently motivated and should be able to take action with minimal effect as mentioned with Behavior Model developed by B.J. Fogg (BJ Fogg, 1998) (Figure 4). Therefore, triggers are strongly related with the motivation. Extrinsic motivation which comes from the environment is based on tangible rewards such as expectations that peers set or hopes of earning a reward. For example, reading a book to prepare for a test or get a pocket money can be an extrinsic motivation to read. Intrinsic motivation is self-sustaining and comes from one’s internal desire for its own sake. For example, reading a book because of enjoyment and self-improvement.

When designing a habit-forming product, understanding the emotions that are tied to these internal motivations are required, as well as knowledge of how external reward can be used effectively to guide a user to take certain action. Therefore, using both intrinsic and extrinsic motivation to trigger the action is important to avoid over-justification effect and effectively deliver their previously set goal (Schneider, F.W. et al., 2005).

In our research, we considered people who is in preparation stage has certain amount of external or internal motivation and from the action they buy or borrow books to read. However not enough motivation which made them hard to grab the book was the point that the interaction device should trigger the user. So we focused on emphasizing intrinsic motivation by showing their will and previous action to merge their emotions in to it such as proud, achievement or steady improvement (positive emotions), and also no improvement or unsteady feelings (negative emotions). At the same time, deliver extrinsic motivation by exposing their progress to the environment through certain given form of goal to succeed or fail.



**Figure 4 Extrinsic and Intrinsic triggers(left) and Fogg Behavior Model, M.A.T relationship(right).**

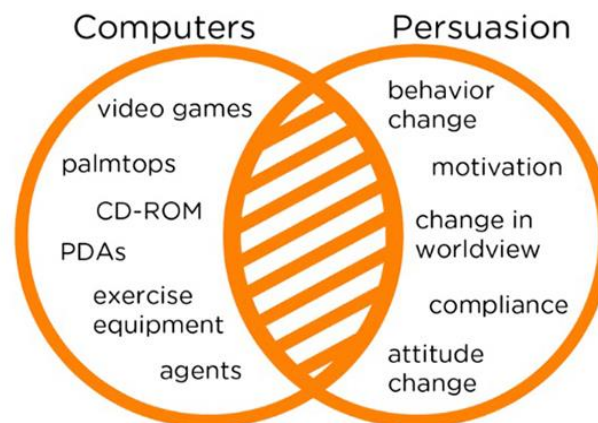
## Persuasive Technology

Persuasion is one of the most effective tools to support change in people’s attitudes or behaviors (O’keefe, D. J., 2008). Using contemporary and new technology to assist persuasion is rapidly developing. The term persuasive technology that B.J. Fogg introduced is defined as “a computing system, device, or application intentionally designed to change a person’s attitude or behavior in predetermined way.” (BJ Fogg, 1998). He also made term “Captology” (Figure 5), which stands for Computers as Persuasive Technology (CAPT-ology). There are a lot of researches based on framework of persuasive technology in promoting physical activities or to motivate healthy aging (IJsselsteijn, W et al, 2006; Intille, S. S., 2004). In diet, exercise, dental care, stress management, and maintaining social relationships. By collecting and processing data through wearable wireless sensor and convey motivational health related information to user via audio and LCD (Liquid crystal display) and even in smaller and convenient form. Moreover, Stephen S. (Intille, S. S., 2004) has mentioned key challenges in presenting information in nonirritating, noninvasive and not burdensome way as followed:

- ✓ **Achieving subtlety** – System to encourage the certain behavior must operate longitudinally, for months or years because many behaviors take a long time to change. Therefore, the technology must maintain a sufficiently high perceived value with the user so that use of the technology is not discontinued.
- ✓ **Detecting the right time** - The sensors required to detect the certain activities will need different ways of collection due to the characteristic of activity and goal. Further, it must not burden the user, stigmatize the user, or jeopardize the user’s sense of privacy.



- ✓ ***Sporadically interacting in time*** - The opportunity to present messages at points of decision and behavior may be fleeting, occurring at brief moments intermixed with everyday life. Just-in time messages must be conveyed quickly.
- ✓ ***Avoiding over-reliance on external justification*** - A motivational technology will, ideally, lead to long-term sustainable behavior change even if the technology use is discontinued. Interfaces that motivate behavior using only external justification may lead to behavior change that dissipates over time if the external incentives are removed.
- ✓ ***Leveraging consumer technology*** - Computer systems that motivate behavior change using just-in-time techniques will be most economical.
- ✓ ***Motivating the “core value” of action*** - These people will use the technology only if it improves feelings of self-efficacy, well-being, or security without becoming a burden. To do so the wearing or maintenance of sensor infrastructure should take little part to perceive the core value and generate essential feeling.
- ✓ ***Proving efficacy*** - Technology is needed not only to motivate the behavior change but also to evaluate if behavior actually does change.



**Figure 5 Captology describes the shaded area where computing technology and persuasion overlap (BJ Fogg, 1998).**

Among these, while designing a technology embedded device to change reading behavior in everyday environment, we considered how to present information taking several factors that mentioned above. Through ***sporadically interacting in time***, we wanted to create an immediate interaction response based on the user’s reading action. To ***avoid over-reliance on external justification***, this was the starting point to consider extrinsic and intrinsic rewards in the direction of interaction that delivers the outcome of reading action. Moreover, to ***motivate the “core value” of action***, the data input method was carefully considered so that it can be linked to reading activity naturally without additional process between reading steps.

## 2.2 Enhancing Reading Interest and Motivation through Method and Interactive Device

### Goal Setting Method

There are strong research evidences exists that goal setting increases motivation and affect performance toward goal (Förster & Souvignier, 2014; Locke & Latham, 2002, 2006; Schunk, 2001, 2003) (Figure 6). The method was also applied in reading activity and researched with students in middle school (Cabral-Márquez, 2015). Setting a goal had a directive effect on cognition and behavior of student themselves, directing attention and effort toward goal- relevant tasks and away from irrelevant activities.

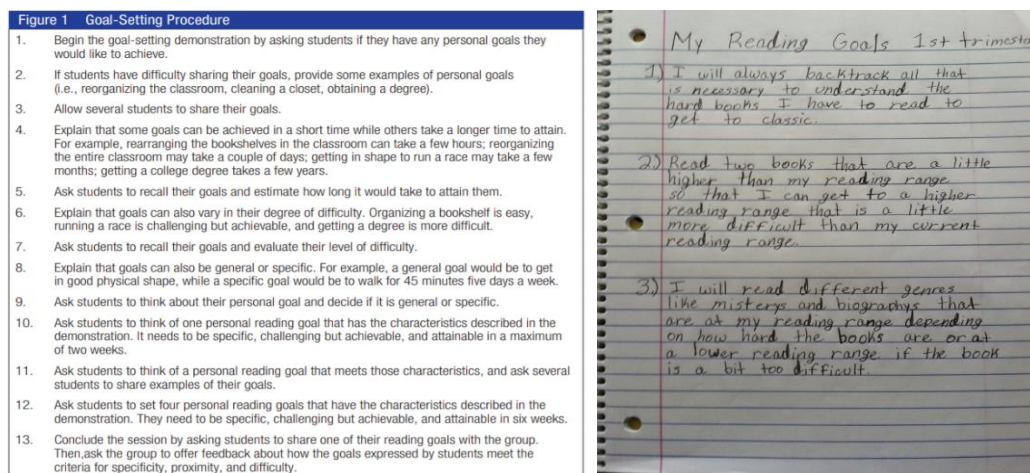


Figure 6 Goal setting procedure (left) and student's set goal (right) through exploring goal setting method (Cabral-Marquez, 2015).

### Interactive Reading Devices

There were several research cases by using interactive reading device (Figure 7). By using smartphone and tablet, Mori et al research team made a conversational agent that the character and reader interact through the pages (Mori et al., 2011). They promoted engage fully into the books while reading through giving various kinds of conversational contents.



Figure 7 Interactive rich reading service (Mori et al, 2011)

There are reading devices that feedback through additional senses, such as haptic, sound, 3D visual and so on. FeelSeeve (Yannier, N. et al, 2015) is an interface that allows children to feel story events through their hands while they use e-book (Figure 8). They confirmed the potential that this haptic feedback could make the reading experience more memorable and improve their engagement while reading.

Reading companion robot, Minnie, also supported the reader to motivate by reminding them to read



**Figure 8 A child reading with FeelSleeve (Yannier, N. et al, 2015) and feeling haptic effects associated with story events on her hands**

and interact while reading (Michaelis & Mutlu, 2017) (Figure 9). This promoted them to perceive reading with the robot and develop the reading interest and ability.



**Figure 9 HCI interactive reading device, Minnie on the left (Michaelis & Mutlu, 2017) and TaBooGa on the right (Linke & Alt, 2017)**

## 2.3 Materiality of Paper Books

### Message in Physical Shape of Paper Book

Material culture research has indicated how relationships to physical objects are important to human lives and works as constructing their own identities and representing those identities to other people (Jane G., 2018; Mann, B.E., 2018). Also, there are irreplaceable functions in digital objects as physical object can give. Previous research has shown that people who uses e-reading technology reads paper books continuously which can be suggested as they are in complementary relationship rather than a mutually exclusive. Studies found out comparing paper and e-book usage showed that there are more emotional attachments to paper book but concerns about ownership to the e-book (Annika H. & Tom R.,2014; Joanne E et al, 2014). Encouraging social interaction around books such as sharing and giving away books could be activated with paper books, but it is hard in e-book with digital right issues (Annika H. & Tom R.,2014; Michael M et al, 2013). Also, absence of physical presences of e-book was an affordance in that they did not ‘take up space,’ but also remarked that it was a limitation as well. The affordances for reading and topological message that paper books give can be various such as (Jane G., 2018; Rouncefield, M., & Tolmie, P., 2011):

- ✓ General storage place such as bookshelf (Figure 10A): large number of books are recurrently situated together. These books were placed there because it is not being currently read and these are understood to be available for reading in the future.
- ✓ Books on the staircase (Figure 10B): fluid and transitory books that is positioned for putting away to somewhere such as returning them to the library or bookshelves.
- ✓ A book on a quite definite place (such as on the bedside table) (Figure 10C): certain spot that one stacks of 'to-read' books, a daily visual reminder of her intention to read them.

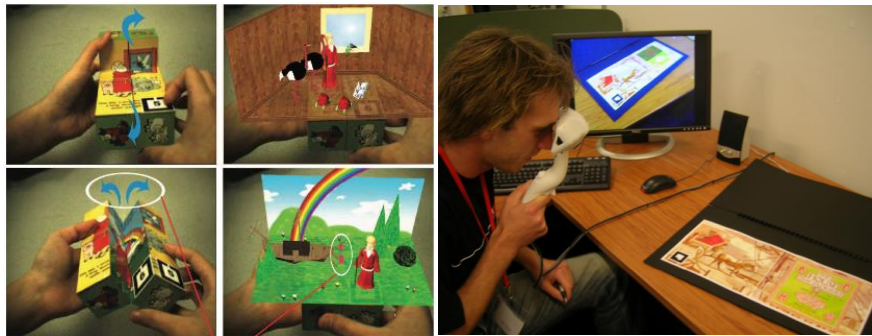


**Figure 10 Books with message through its position. A) in the bookshelf,**



### Interactive Device Combined Paper Book and Digitalized Book

Like Magic Story cube, Mixed Reality Book (Figure11) and Flippin' (Figure 12) there are many researched suggesting interactive reading device based on the topological message that physical books deliver (Zhou et al., 2014; Grasset et al, 2007; Koichi et al, 2017). They combine the materiality of book and functionality of digital to promote interest and engagement in reading.

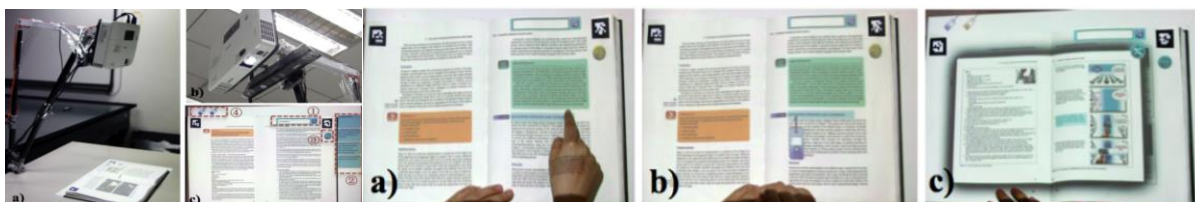


**Figure 11 Magic Story Cube on the left (Zhou et al., 2014) and Mixed Reality Book on the right (Grasset et al, 2007).**



**Figure 12 Flippin' (Koichi et al, 2017).**

Qook (Figure 12) is also a system that blended the benefits of both physical and digital books to facilitate active reading. The top-projector fills the blank paper as the user reads and interact with user's gesture to do certain tasks such as highlighting, bookmarking, searching the words and so on with Kinect sensor. This gives opportunity to navigate faster between pages and understand the contents better through providing natural reading experience.

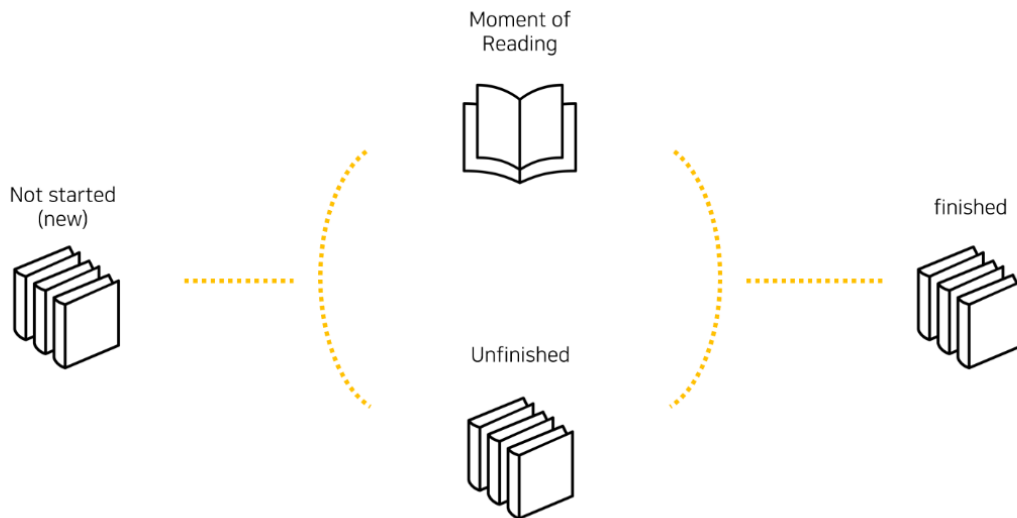


**Figure 13 Highlighting and Bookmarking through gesture with Qook (Zhao et al, 2014).**

## Chapter 3

# Bookly

### 3.1 DESDIGN FEATURES



**Figure 14 A detail steps in reading process**

Steps of reading can be finely divided into four steps as Figure 14. A first step that when a person bought or borrowed a book but have not started reading yet. From the moment a person opens the book, there is a moment you read it, and you put it down to pause reading (unfinished book) and these two steps iterates until the book is finished. The common factors that previous studies share is, they enhance readability and effectively deliver contents or promote interest and engagement in reading while in the moment of reading. However, there are not many studies that considers the detail steps in the activity of reading and whole reading activity's flow. People in preparation stage are more related in the steps where the book is closed (like not started phase or unfinished phase). So, reminding their action's position can help users to constantly perceive their current state of reading which is the initial step in inducing the preparation stagers to do the action.

Bookly's design aims the readers to be naturally encouraged to pick up the book by differentiating one book that is currently trying to read and physically accumulating time that is related to reading. Bookly is a timepiece that visualizes the accumulated pick-up time of currently reading book through head's vertical and horizontal volumetric movement. main features of Bookly are as followed:

### **Physicalizing the accumulation of book's pick-up time**

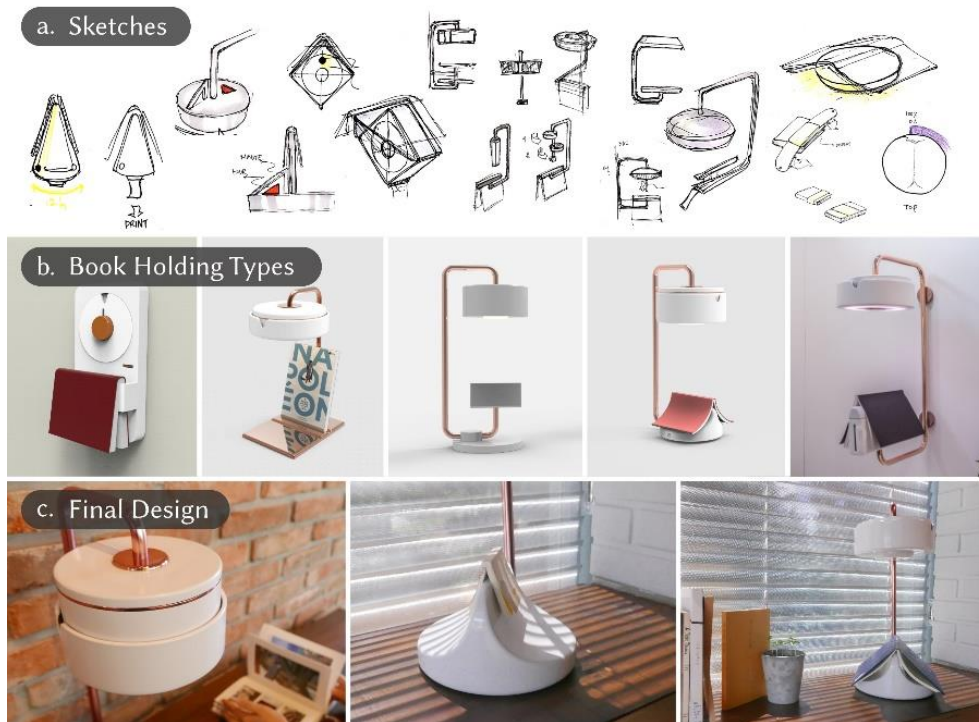
The design of Bookly started from understanding role of the bookshelf. A bookshelf's basic purpose is to store books. By storing it vertically in a line, books can be exposed and reminded their existence in the everyday space at the same time. Taking bookshelf's conventional roles into account, we wanted an everyday object that provides a new interaction related to reading data. Instead of delivering the textual information about reading book or its contents (Crasto, D et al., 2005; Matsushita, K et al., 2011), we concentrated on closely bridging the visualizing data with action of reading and his/her implied motivation. Bookly presents the accumulated time of how long he or she has picked up the book that has chosen to read. Furthermore, instead of showing how much number of books or pages has been read, we set the accumulating data unit as time considering that people can spend and feel differently regardless of the number of read pages. In other words, accumulation can contain the time they pause reading and ponder over phrase that they just read and even a short trial that they picked up to read. Thus, Bookly shows how long the user's book has been picked up through gradual volumetric movement from minimum size until it reaches full volume. Through this, we explored how Bookly's interacting method can influence motivation and change the direction of one's progress in reading.

### **Designating spot for the ongoing book**

If the user places a currently reading book on his or her bookshelf, it can be easily forgotten (Hupfeld, A., & Rodden, T., 2014). In more detail, the only communicable part of the book in the bookshelf is the spine (Matsushita, K et al., 2011), which is close to passive to attract readers. Thus, while designing Bookly, one of the main considerations was to give difference between a currently reading book and the others in positional way. We specified the location by designing Bookly as a table type and placed the ongoing book to be near one's active area. The volumetric movement was performed above the ongoing book location to connect the flow of user taking out the book and the following accumulation. When the user is not reading, a book must be placed on the mountain shaped part of Bookly stand to stop cumulation, and it will be kept open in a visible spot. Through Bookly, we tried to explore new reading experiences by designating the on-going book location.

### 3.2 ITERATIVE DESIGN PROCESS

We devised over 20 concepts through sketches, rough prototypes, renderings, and mock-ups (Figure 15) based on the design direction. The design process was started from understanding the various book storing forms. For example, leaning a book on the wall or stand, hanging a book with a strip, or putting the book on a mountain-shaped holder (Figure 15c) and so on.



**Figure 15 Design process of Bookly. a) Ideation sketches, b) Bookly holding type variations, c) Final design**

Among them we selected our holder as the mountain-shaped type which can keep the book in not fully closed way and deliver the message that the reading is ongoing. This shape can help users to pick up the book and be on a page that one was easily in minimum action. Also, to merge overall shape of Bookly (Figure 15c) in the context of reading, a lamp form was selected to set a reading mood. Lastly, Bookly's head part was designed to simulate the volumetric change in physically and ratio was considered with the below body.



## **Disk Shape Head Design**

The design of Bookly's head part delivered the flow of time to the user in a slightly different form and express it more abstractly. We wanted to show the passage of time naturally and avoid direct interactions of the clock at the same time. The horizontal axis of the normal clock was changed vertically. The indication method of 1 hour per rotation remained and the expression of the accumulation of time was newly defined as vertical expansion.

Furthermore, with the equal ratio of head part and bottom part was to inform that the act of reading books is equally important as the existence of the book which will be placed beneath the head. Additionally, we tried to bring the feeling that one's reading experience is filling slowly but in a massive way.

## **Setting Time among 3 to 12**

As mentioned above, rather using objective indicators such as the number of books or the number of pages of books, we used the abstract indicator of time to use the unit that can contain the meaning of each user. Accordingly, the setting unit of time was provided in four choices (3, 6, 9 or 12 hours). For the people in preparation stage, it was important to make them aware of their behavioral changes and that it needed to be able to get immediate feedback on their behavior in every use. Therefore, we thought about the time within a day (24 hours) and gave time options considering the individual differences based on how much reading time can be spent, focusing on people who have different work and own time. In the process, we wanted to provide only a limited set of options to avoid a setting step that needs too complicated or too much thinking.

We considered various usage scenarios as follows:

1. I will read a certain book in this set time. (fixed book, fixed time)
2. I will read this set time for a week. (fixed time, set duration)
3. I will continuously fill up the set time. When the time is over, start over again. When the book is finished start another book.
4. Pick up the book from 6pm-9pm whether I read that book or not.

Like this, the user was able to create his/her own usage scenario and adjust usage direction as they continuously use Bookly. Therefore, the main goal was to firstly start to gather the time they read and then slowly find their own way or pattern to read to adjust.

### 3.3 IMPLEMENTATION

Overall, to enhance Bookly’s quality in finishing and fit the usage environment the fabrication was carefully considered to become a research product (Odom et al., 2016). Also, through iterative technical development, we increased its stability as an independent device for the infield study.

In Bookly’s head part, two motors are inserted to enable the movement. A stepper motor (Figure 16g) is used to control the horizontal rotation and a DC motor (Figure 16f) for the vertical movement. We developed stable rotational and volumetric movement of the disk’s outer case to control independently.

In detail, the DC motor is fixed underneath the inside ceiling of inner disk’s (Figure 16a). The motor rotates the three stud bolts together delivered by gears, and this makes a middle plate which is interlocked with these bolts moves up and down (Figure 17). The body of a stepper motor is attached with the middle plate and motor’s rotating poll is connected to the floor of outer disk. In this way, without any fixation on the side part, the outer disk can move vertical and horizontal way. Additionally, the infrared sensor (Figure 16j) is placed on the outer disk’s floor to sense the book’s presence and three LEDs are attached around the sensors. Inside Bookly’s bottom body case, there are an Arduino board, real time clock, and SD card module (Figure 16k) to save when the book is picked-up and put-down to collect log data. With 14 pines, these parts are connected through the pipe (Figure 17).

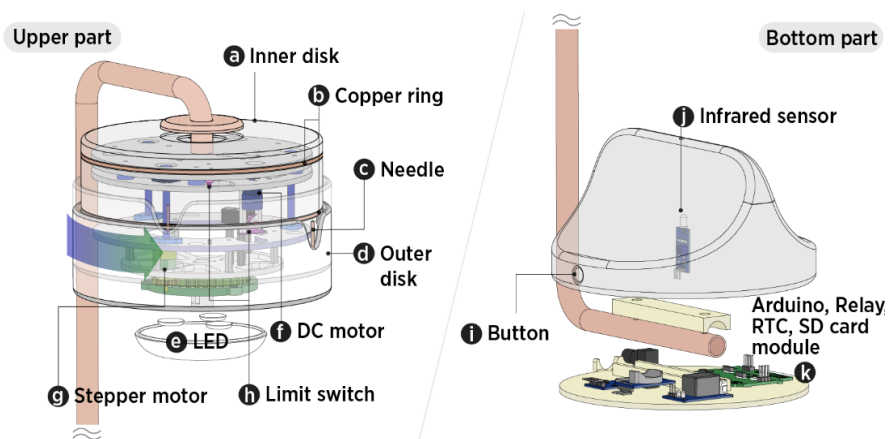


Figure 17 A detail inner structure of Bookly

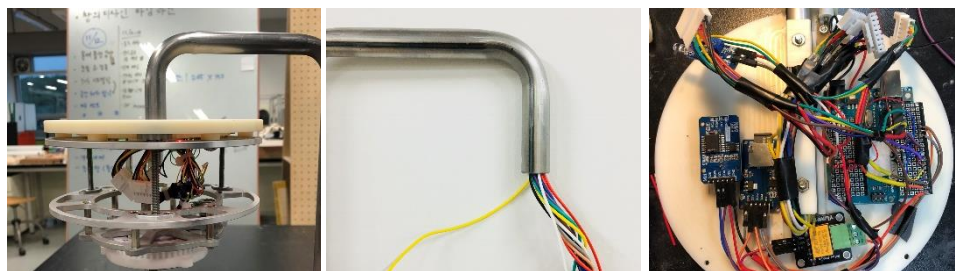
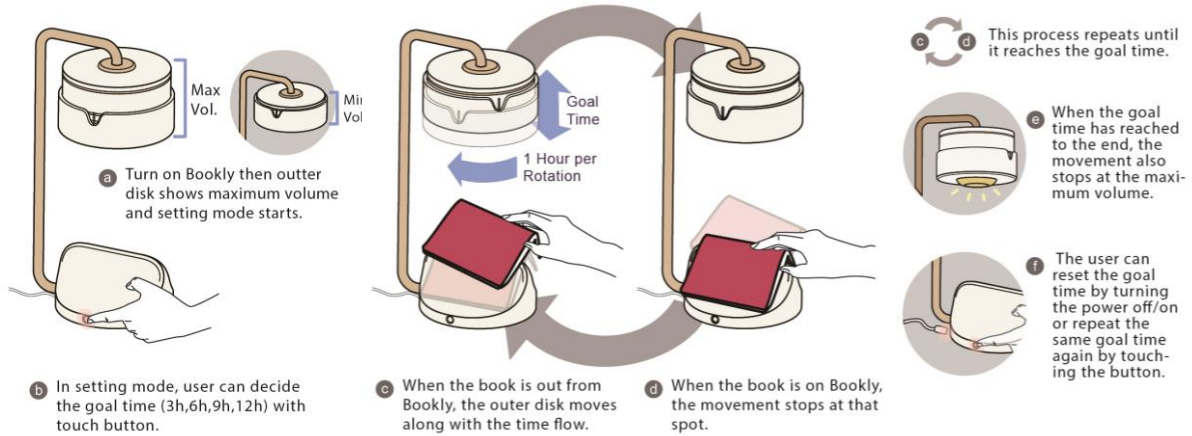


Figure 16 Prototyping: inner structure in process. Three stud bolts interlocked with moving middle plate (left) and lower part (right), and lines connection through pipe(middle).

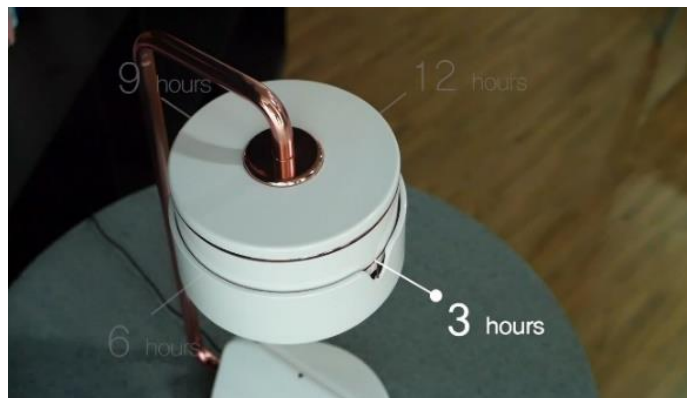
### 3.4 USE OF BOOKLY



**Figure 18 Interaction of Bookly**

#### Set-up Mode

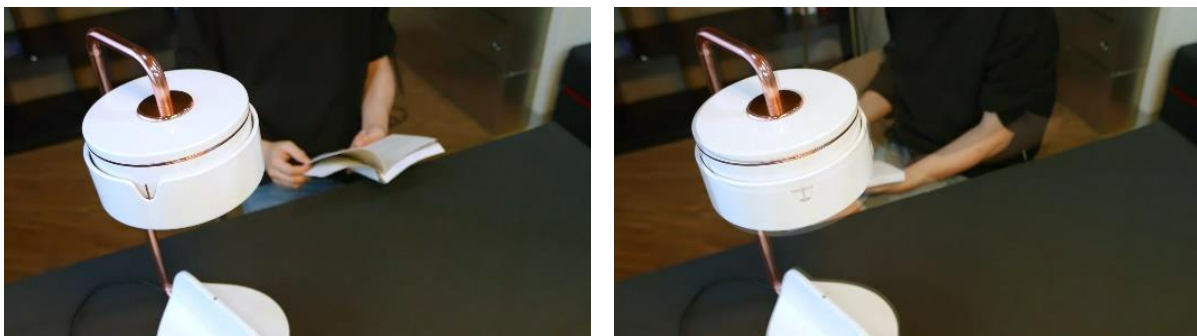
Firstly, when the user picks a book to read, they need to plug in Bookly to start. The upper head expands to the maximum volume (Figure 18a). After it reaches the maximum volume, by touch button on the side of the lower body (Figure 18b) the user is able to choose their goal time among 3h, 6h, 9h, and 12h (Figure 19). One touch will move outer disk 45 degrees to show which hours to pick. This will set as the outer disk's duration from the initial volume to the maximum volume. The maximum volume of outer disk is always the same, but according to the user's set time, the expansion speed changes. When the user waits for 5 seconds at the point that s/he wants to set as their goal time, the outer disk shrinks to the initial point and the counting starts.



**Figure 19 Set-up mode**

**When the book is taken out from Bookly.**

If the user tries to read and picks up the book from Bookly (Figure 18c), the outer disk's slow movement will show the flow of time (Figure 20). Users can abstractly know how much time has flown through outer disk's two ways of movements. 1 horizontal rotation indicates 1 hour and vertical volume change shows the accumulated time. The two-cooper line (Figure 18b) on the side of inner disk indicates the starting and finishing point. When the needle on the outer disk meets the upper cooper line, it means the user is in starting point. When the needle meets the lower line, it means they reached goal time and user can see the maximum volume. So, user can abstractly read the accumulated time with these lines (Figure 18c).



**Figure 20 When the book is out from Bookly**

**When the book is taken out from Bookly.**

After reading, when the user wants to pause reading, s/he can put the book upside down on mountain shaped lower body (Figure 18d). This will make the movement stop until they pick up the book again. The accumulation will continue from the previous position when the user resume reading (Figure 21).



**Figure 21 When the book is on Bookly**

## Reaching the goal

When the user has filled up to the maximum volume (Figure 18e), the user can see the lightened LED underneath of the outer disk with the maximum volume (Figure 18e). It will remain at this status until the user touches the button. If s/he touches the button, the size will shrink to the minimum and with the same goal time, the counting will begin (Figure 22). When the user needs to change the goal time, s/he has to turn the power off and on to be in the setting mode (Figure 18f).



**Figure 22 Reaching the goal time**



## Chapter 4

# User Study: Field Trial

### 4.1 STUDY GOAL

To find how Bookly affects the users overall reading process in the user-friendly environment, we conducted an in-field study for 2 weeks. Through this, we wanted to look deeply into 1) how physical representation of reading progress with volumetric movement in everyday life can influences reading habits of the users; and 2) how giving the positional difference of ongoing book and the others affects the book's accessibility and the connected reading.

### 4.2 METHODOLOGY

#### Participants

We thoroughly chose 6 participants who are mostly busy and young (P1-P6, 4 females and 2 males, age 20-28) from about 50 applicants: 1 part-time worker, 1 startup intern, 2 undergraduate students in vacation and 2 lab researchers. We selected these participants under following criteria:

- ✓ People who recently happened to have their own time and space without someone involving in their living constantly.
- ✓ People who borrow or buy over a book in a month and know about importance in reading
- ✓ People who are in preparation stage in reading (Prochaska, J. et al., 1992). In other words, they tried to read but failed and think their reading amounts are is unsatisfied.

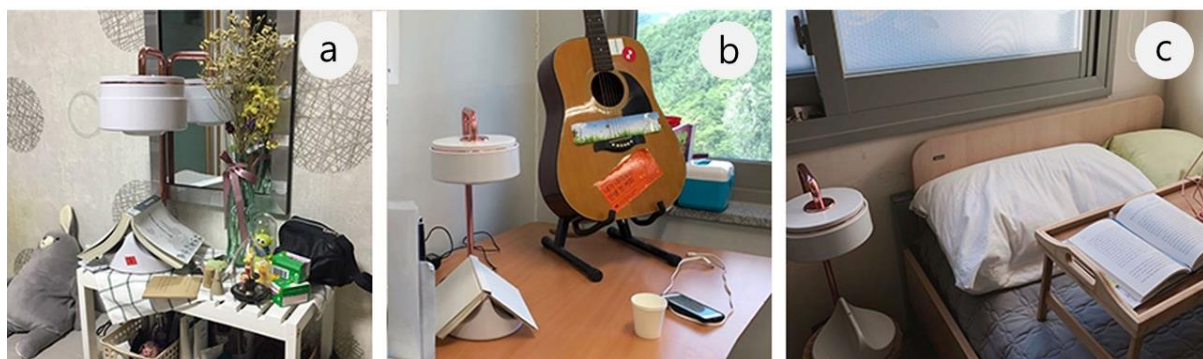
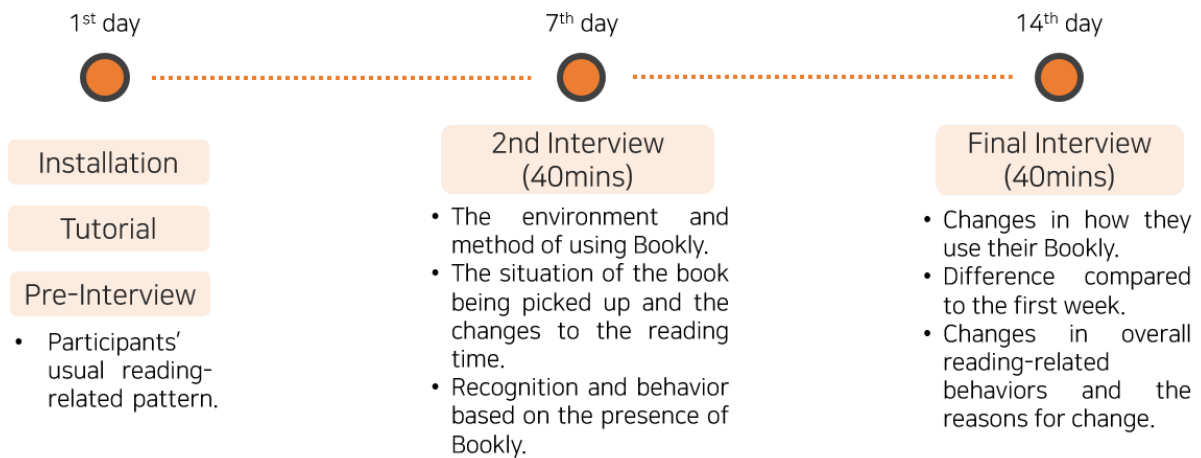


Figure 23 Bookly in situ. a) P1's room, and fully expanded volume, b) P2's office, c) Reading on her bed in P3's dorm

## Deployment and Interview

We visited in users' usual reading area and installed Bookly on the first day. Those places were where they spend over 5 hours a day and feel most comfortable to read. Bookly was placed on the side table of the bed at P1 (Figure 23a), P3 (Figure 23c), and P5 home. P4 and P6's Bookly was installed on the desk at home, and P2 (Figure 23b) placed her Bookly on the desk of start-up office. We conducted 40 minutes interviews 3 times. Pre-interview on the day 1, middle interview on the day 7th, and final interview on the day 14th (Figure 24). The contents of interview questions are in Table 1. In addition, to analyze the changes in reading amount or pattern of participants, we collected log data to mark every time when the book is picked up and returned on Bookly. However, participants did not need to go through additional step to record the time because the infrared sensor did it automatically.



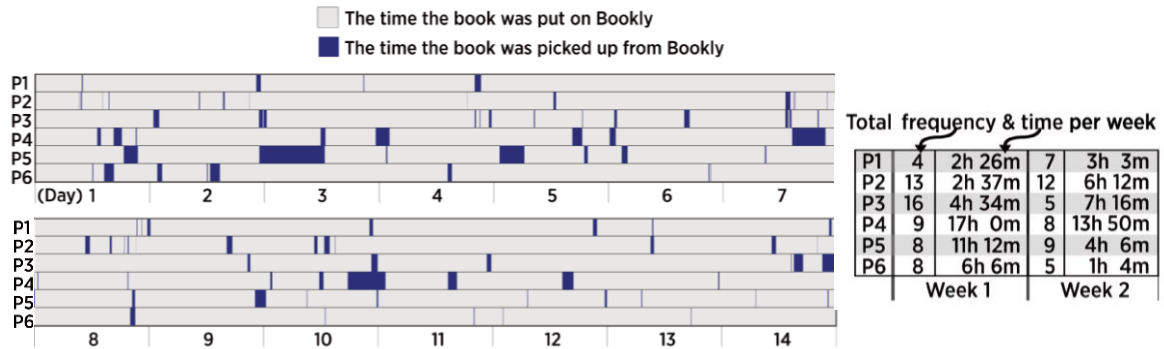
**Figure 24** Field study schedule and detail

**Table 1** Interview contents following the date

Date	Interview questions
<b>Day 1</b>	Participants' reading-related pattern information (e.g. reading time, way of keeping books, reasons for reading). The first impression of Bookly.
<b>Day 7</b>	Their environment and method of using Bookly. The situation of the book being picked up and the changes to the reading time. Recognition and behavior based on the presence of Bookly.
<b>Day 14</b> <b>Final day of use</b>	Changes in how they use Bookly compared to the last week. Any kinds of difference in reading compared to the last week. Changes in overall reading-related behaviors and its reasons and specific situation.

## Bookly Data Logging

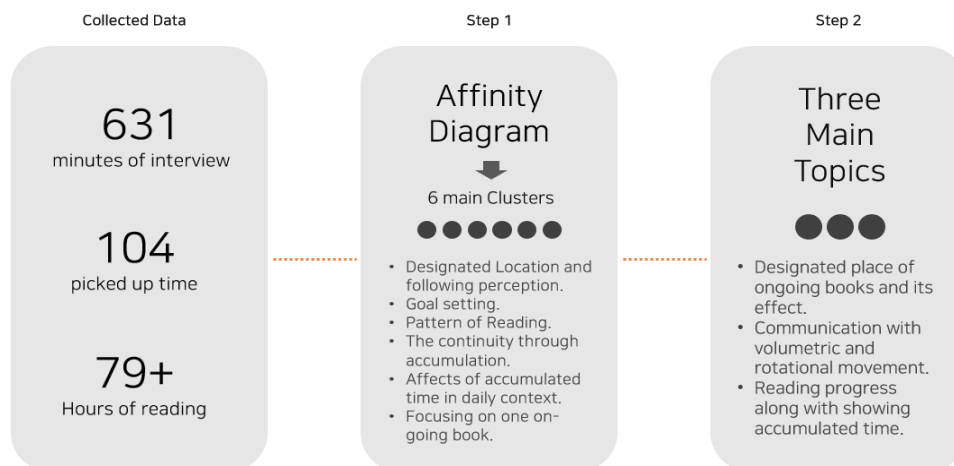
Bookly usage information was stored as a “.txt” file in the SD card inside Bookly. Log information of the date and time of user picking up the book, and the date and time when the user puts the book down were saved as text file. Through this information and interview data, we could identify how much time the participants read and used Bookly during the field trial. In addition, we collected photos and short memo of usage every day.



**Figure 25 Usage log data of six participants over two weeks (left). The right table compares week 1 and 2’s total frequency of the book’s pick-up time and the total time after the book was picked up from Bookly**

## User Data Collection and Analysis

Through interviews, we collected 631 minutes of verbal data and they were recorded and transcribed. The interview statements’ reliability check was done with the log data and were categorized through affinity diagram and (Figure 25). By iterations in groupings, we classified three main topics in result (Figure 26): communicating with interaction of rotational movement and volumetric expansion, the effect in designating the spot for the ongoing book and accumulation of reading time and its relation in reading progress.



**Figure 26 Collected data and analysis flow**



## Chapter 5

# Findings & Discussion

During 14 days of in-field study, books were picked up for 79+ hours and 104 times (58 times in first week, 46 times in second week) from Bookly in total (Figure 25). To understand the time in use and changes in pattern with the statements in interview, we utilized these log data.

### 5.1 FROM VOLUME CHANGE TO READING HABIT

#### Messages in Volume Change leading to Understand Reading Routine.

Through in-field study, we could find the volumetric change implicating user's reading status amount in daily space can be translated into reading related message to the users. Most participants did not give close attention to the movement while reading. Instead, they recognized the change in volume while grabbing the book to read or while putting the book down (N=4). Additionally, five participants perceived the change normally while passing around Bookly. P3 said, *"When I came home from work and faced Bookly, I felt something because I could see the expanded volume. The needle had stopped. So, 'oh, yesterday I moved it half a cycle. I should rotate it the other half as soon as possible'..."* The five participants noted whenever they sensed the change in volume, it came to them as a positive message that they are in progression. At the same time, when they could not feel the change for a long time, it gave them a little pressure and made them think *'I should read soon.'*

Moreover, all the participants stated that they could recognize their previously unknown or ambiguous progression in reading due to the constantly showing volumetric movement and its delivering message. P2 commented, *"Before... Even though I have been reading a book for about 30 minutes, it did not come to me as time; I just felt that I had read some today. But, because Bookly collects and shows [the reading time], I could know that I was reading a book in this way."* P5 mentioned, *"I feel like I could see what I did. Previously, the reading didn't mean a lot to me. I did not think I read a lot of books, because I read and stopped little by little... But it felt like Bookly was connecting them. So, now I can feel I'd been trying to read a book by myself. It feels good... I feel like reading is now part of my day."* Through the interview, we could see the participants feeling proud of their efforts and time they spent to read, not because how many pages they had read. Having this kind of new perspective in reading amount, this could work as a self-reflection exercise.

## **Trials in Settling Reading Time in their Schedule**

After seeing how their reading routines are in the first week, all users started to create independent time to read within their schedule or tried to take different reading pattern to improve their recognized weaknesses during the last interview. P5 noted, *"I started to think about the plan—about the original habit [of reading]. Originally, I did not check how much I was reading because I read from time to time. It felt like Bookly was connecting the reading time by counting (by means of Bookly's outer disk) on and on, so after that I thought that my previous reading pattern was not so good. So, I thought I would like to have more time to read longer, not fragmentarily."* In detail, P1 and P5 stated at the beginning when the counting starts from minimum volume, they partially thought when and how to read until it reaches the goal. Additionally, three participants said they set certain time in their day to read, such as, *"when there are few people in the office after work (P2)," "before going to bed (P3)," and "morning time before exercise (P6)."* As we can know from the log data (Figure 25), P2 and P3's number of picking up their book has decreased on the 2nd week, but they spent more time to read. Comparing it with the interview statements, this can mean that they combined fragmented reading time into one by finding a certain time in their daily life.

In line with previous studies (Consolvo, S et al., 2009; Festinger, L., 1962), we could identify the volume change from Bookly can work as that reflect one's actions, and could work as an opportunity to constantly perceive one's unrecognized progress in reading. In addition, when the user senses their behavior is inconsistent and unsatisfied, it can transform into a motivation to improve their behavior in the form they want (Consolvo, S et al., 2009). Moreover, users could be continuously motivated through this and encouraged to find a time to read in existing schedule. Also, we could see this as an initial step in leading them to set their periodic reading pattern.

## **5.2 LOWERING THE WALL TOWARD READING ACTIVITY**

### **Enhancement in Accessibility of Ongoing Books**

Most participants stated the positional difference made by Bookly and differing the manner of storage shape could increase the accessibility to the book that they are reading. P1 commented that after using Bookly, she always took out the carried book from her bag and put it on Bookly after work. Before Bookly was with her, even though she carried the book at home to read she kept it inside her bag. Additionally, putting their book on the mountain-shaped holder worked as a trigger to pick up the book more often. P1 mentioned, the book looked more *"active."* with the stored shape that Bookly provided. P2 stated, *"It's upside down and spread out... Certainly, I picked up the book more often than the book that I put here (nearby bookstand). My hand reaches here first, and then I feel more like [the reading]"*

*is continued.*” Regarding the designated book’s position, P4 said, *“If there wasn’t Bookly, I might have put the book away and felt cumbersome, even though I put the book in the same place. And I do not take the book out again once it is put aside. Certainly, [through Bookly] the place [of the book] is fixed, so my hands tend to reach there more often because the space is provided, and it was seen... ‘Oh, that book was there’ ... and I think about the books once more.”*

Furthermore, we asked how it will feel if a book is placed on the same spot in the same way without Bookly. All the participants mentioned the book will seem like it has temporarily situated after reading and very soon it will feel like it must be organized somewhere else. But with Bookly, they noted that the book seems to be arranged and settled on the right spot. Through this, Bookly’s presence allowed the book itself to deliver the message that this book is in progress continuously and naturally induce the accessibility to it by using implied message that the paper book’s storage shape and location have (Hupfeld, A., & Rodden, T., 2014; Rouncefield, M., & Tolmie, P., 2011).

### **Inducing Continuous Reading**

We could able to find out that Bookly made five participants to clearly aware of themselves that they are in the progress of reading and they continued to read often. P4 referred to the accumulative time as his “concentrated time.” Five participants mentioned that quiet but recognizable movement of Bookly while reading has made them focus more on reading while the book on their hand. P3 said, “While the book is out, the priority changed from phone to book. It keeps on moving, so I can perceive that. ‘That keeps moving, so I should stop using my phone.’ ‘Oh yeah, I was just reading that book!’ I feel like it reminds me of my duty ...”

Furthermore, Bookly has made P5 to continue reading even if Bookly was not with her when she was out. She mentioned, “When the volume of Bookly itself is becoming bigger, the more I felt like I read this book. I went out to read the book, so if it is not recorded... well... it would be not good. I went out without putting [the book] on Bookly [but with a book] on purpose. So, I read it outside more often than before. I was also motivated while I was out, too.” P2 and P3 stated they started to read more even they are not with Bookly, such as, on a bus (P2), between classes (P2) and taking rest in her office (P3). Additionally, most participants noted that they wanted to be near Bookly while they are reading. P6 usually read the book in bed so she used her basket with lid as a bedside table to put Bookly beside bed, bought a small table to use inside her bed and a mood lamp that goes well with Bookly. Like this, we could find that as the time goes Bookly and other objects were combined to make reading atmosphere they wanted to create.

On the other hand, P6 noted when he was reading with Bookly he felt pressure that time is ticking, and keen respond went through until the end. Through log data (Figure 25, P6), we could also see that he rarely picked up his book from Bookly from the second week of use. He also confessed that he sometimes put his hat on Bookly to make the time stop while he was reading. This taught us another perspective about time counting to connect with individual goal achievement and it requires careful deliberation when it has possibility to interpret different message due to each user.

Through this, on the same line as the previous studies (Consolvo, S et al., 2009; Locke, A., & Latham, P., 2002), having constant indirect perception of time flow after setting the individual goal can induce the self-efficacy and lead to the following performance of the intended task (Locke, A., & Latham, P., 2002). Moreover, design element of Bookly played a role in transforming participant reading routines and expanded its influence to build their preferred reading spaces.

## **5.3 DISCUSSION & LIMITIATION**

### **Presenting Self-Reflective Data**

Even though our finding has a limitation in short length of in-field study to find whether it leads to the maintenance stage (5th stage), 2 weeks of study showed Bookly's design could extend the participants from the preparation stage (3rd stage) to act (4th stage) (Prochaska, J. et al., 1992). In that respect, we could confirm several factors to include when presenting self-reflective data should include to achieve goal in more effective way. One is delivering the progress in abstract visualization. Without any marked scale, Bookly expressed their goal related data in volumetric expansion in physical way. Bookly's ambiguous data deliberation can induce positive pressure that naturally lead them to perform trials related with goal (Consolvo, S et al., 2009; Locke, A., & Latham, P., 2002). Also, to drive behavior changes by showing self-reflective data, considering characteristic of delivering data is important. We chose time as relative data and that made possible to include the subject's attitudes, efforts and trials rather than absolute data that only shows the results. We suggest that using personal informatics in behavior-inducing method (Elsden, C. et al., 2015) can provide self-motivation for any goals that someone feels hard to accomplish and perceived as constructive (e.g., watch less TV, doing exercise).

Additionally, with Bookly's continuous movement while reading, one participant felt pressure until the end. Taking the interview data with other participants, data output timing can be changed to immediately after putting the book back on Bookly rather than whole time while reading. Therefore, issue of pressure can be improved by bringing the change in data not when users are focused on the main activity but when it is finished partially.

## **Exposing Physicalized Data in Everyday Life**

Exposing the physicalized metadata (Odom, W & Duel, T., 2018) related with desired work to accomplish through tangible object in everyday life may work as a symbolization of the intended work (Willett, W. et al., 2017). This will lead the constant reminding about their self-commitment and drive a gradual behavioral change (Festinger, L.,1962). Moreover, physical referent's existence may transform into self-representation in public space or when someone visited in one's space and has possibility to induce conversation about their goal by publicly showing the desire by object (Hornecker, E., & Buur, J., 2006; Hupfeld, A., & Rodden, T., 2014; Jansen, Y. et al., 2015).

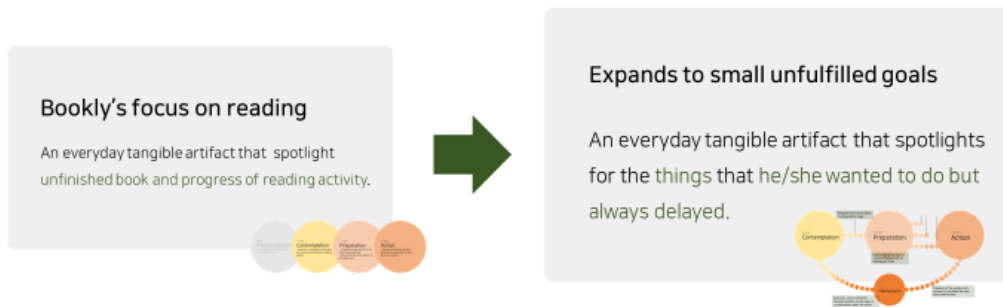
Additionally, these implications can be expanded to improve not only paper book' reading pattern but also digitized readable content such as e-books, web news and articles. By giving a tangible existence to metadata about readable digitized content, the physicality that reminds of digital reading content will be increase the active awareness and its existence (Festinger, L.,1962; Hornecker, E., & Buur, J., 2006). Furthermore, this will influence the motivation towards read digital materials and generate interpersonal relationship.

## Chapter 6

# Implication

### 6.1 DESIGN IMPLICATION

Our findings and discussion implied that how showing physicalization of self-reflected data in an everyday tangible object might motivate natural behavior change. By abstractly exposing the visualized the data that is related with user’s previous will in everyday surrounding will make them aware of their trials, efforts and attitude towards the goal. Visualizing the data’s progress in abstract interaction can be extended in various forms. 1) Referring the existing object that relates to the goal and add continuous motion change to certain part or 2) enable goal related input and connect to the daily elements that can indicate the degree (ex. Bright/dark, slow/fast, light/heavy, full/empty etc.).



**Figure 27 Examples of plans integrating into short-term plans**

Through the direction, we explored interactions through ideation brainstorming practice (Figure 28-30). We expanded target behavior for reminding from reading to any kinds of goals that couldn’t be done due to weak motivation (Figure 27) to focus more on progress interaction. We used A5 paper to draw each idea on a sheet and grouped them in sharing elements. Largely, one group were based on token that writes the goal on it or represent single token as one goal and use it as an indicator (Figure 28). Additionally, a token could be used as an input to certain movement such as plant-growing-like interaction, shredding, height of light gradually increases. Interaction that spotlights the goal related item with movement was grouped such as a large plate that gradually light-up after the item is placed or a pole with a height changing plate to indicate progress degree with its height (Figure 29). A group with interaction that reminds trail of goal related progress through volume change in ball shape, or rotating color panel, or objet like rotating stick has also come out (Figure 30).



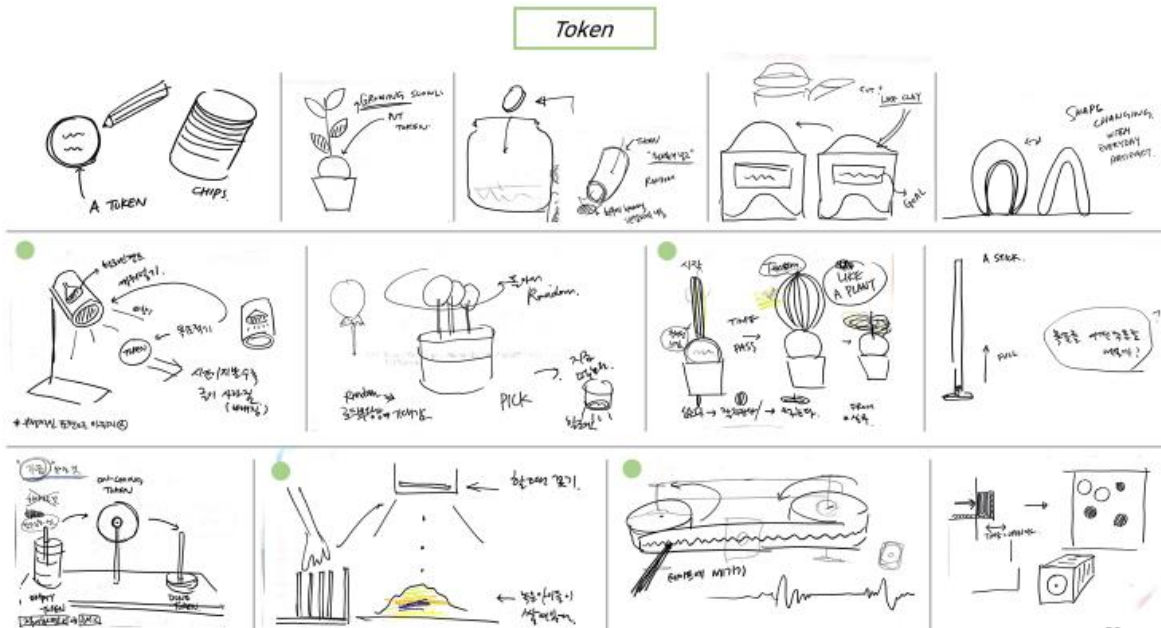


Figure 28 Token based interaction brainstorming.

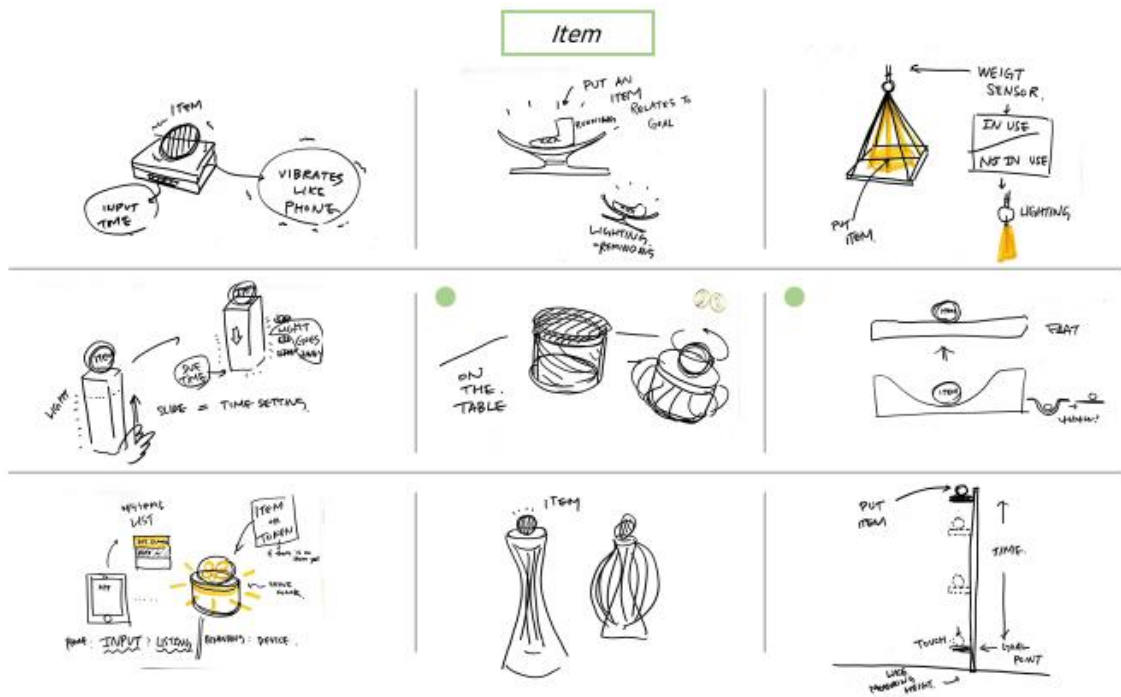


Figure 29 Goal related item-based interaction brainstorming



Figure 30 Goal related time trace reminding interaction brainstorming.

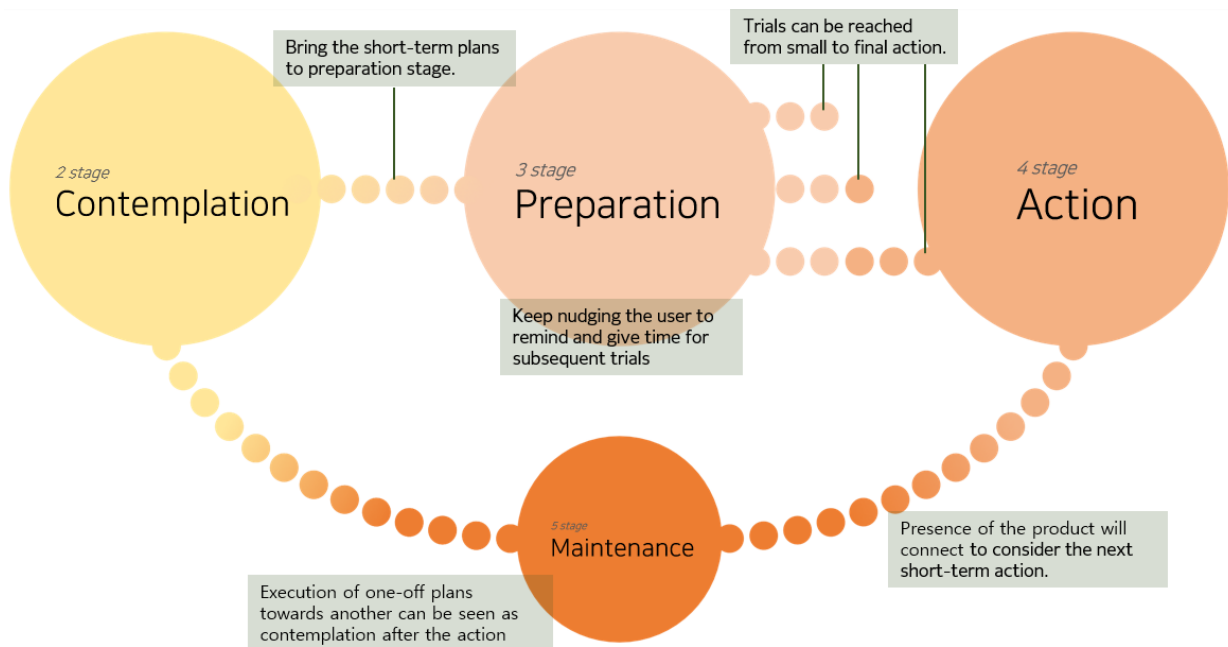


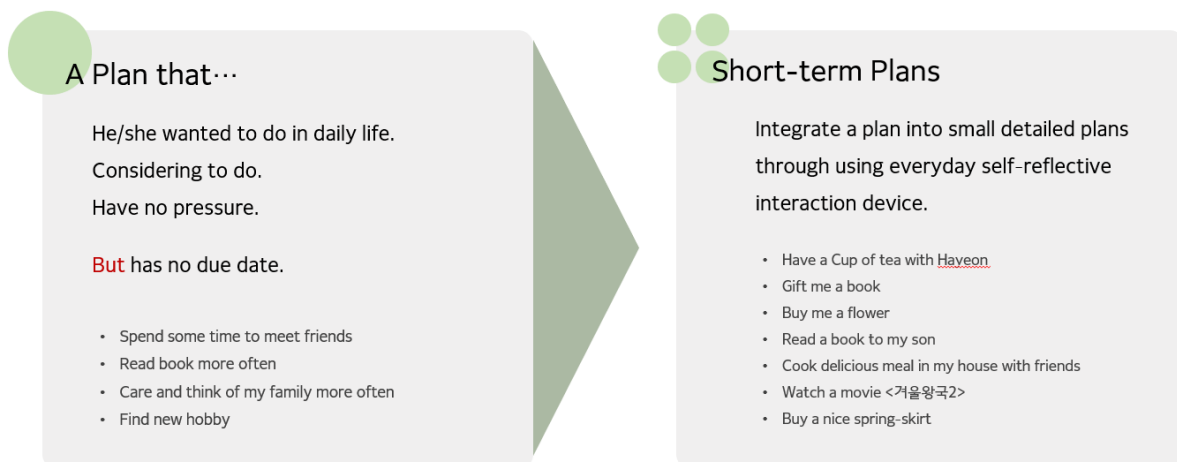
Figure 31 Reinterpreted Transtheoretical Model in iterative form.

Through implication we explored different deliberating ways of abstract exposing ways of progress related data in everyday life. By familiarizing these interactive referents as everyday product that relates with will, this can lead to continuous recognition of their behavior and understand their pattern and make the thoughts and processes of will more active. By expand the reading activity into any kinds of one-off plans which were difficult to perform due to the weak motivation, we could apply the value into more various goals (Figure 27). Such short-term plans that is seriously considering doing but hasn't committed to take action which can be found in the stage 2, contemplation stage. So, by using the Transtheoretical Model, expected iteration is as followed (Figure 31).

First by selecting one plan to use with the device, a one of short-term plan which was stuck in the contemplation phase can move to the preparation stage. User will be keep reminded with the device's constant interaction in everyday life and eventually there will be some subsequent preparational trials. The trials can come together to reach a small trial like action and eventually final action. Even after one short-term plan is finished, the presence of device will soon connect the users to consider the next short-term action, which will bring them to another contemplation phase and go through this in cycle. This can be seen as a maintenance stage for the execution of one-off plans towards another. In brief, this expand from the reading activity to small unfulfilled goals due to weak motivation and expected to supplement the behavior stages that Bookly could not cover which are the 2nd stage and the last stage (Figure 31).

## 6.2 EVERYDAY DESIGN ARTIFACT FOR ACHIEVING SMALL GOALS

Based on the expanded area of settable goal and interaction brainstorming, we suggest one of the directions to naturally encourage the user to remind progress of short-term plans with abstract exposure in everyday life and developed with detail design and scenario (Figure 32).



**Figure 32 Examples of plans integrating into short-term plans**

While expanding from certain activity(reading) from various kinds of one-off planed activity, we considered how to cover different characteristic and context of different goals with one same device. To blend into the everyday context, we came up with the similar term “D-day counting”. The part getting closer to one’s desired but unfulfilled behavior can be seen similar as D-day setting. To increase the self-reflection phase and minimize constant negative motivation which will directly affect the experience to pressure of the goal, we carefully considered familiar factor in everyday living and decided to use light and slow playback like movement as indirect reminding interaction.

## Design of ReeLit

The design of ReeLit (Figure 33) aims to naturally encourage the user to remind their willing activity by gradual lighting expansion feedback and continuous playback of belt movement during set day. ReeLit is a referent object that playback of willingness of one’s goal and constantly nudge them to think about their previous set goal and what to set. ReeLit’s main features are as follows:



**Figure 33** ReeLit waiting to start the slow counting to the goal day.

### *Goal inside a dial*

To allow to set any kinds of goals that different users have in mind, we needed 1) a token to indicate the set goal or 2) a related item or 3) something to write down. These inputs should be not vague to avoid neglecting the goal, or to convey it so strongly that it puts pressure on reminding too directly. To do this, we thought of the direction of sealing the indication of a goal in any way and connect it to the object to be a button to set D-day. Therefore, by using a small box that could hold a post-it to write down the goal with a pen, its usage could be naturally connected to the input button of a dial interaction when it is closed.

### ***Gradual Change: Brightening Area of Light***

By using the amount of light to convey the passage of time abstractly, we wanted to deliver a contained message and naturally merge in everyday life at the same time. The indirect lighting will face the wall so that the brighter the light gets, the larger the size of the light reflects on the wall. Also, like Bookly's way of delivering message through volumatic change, ReeLit also counts every second but reduced the accuracy of the delivery to reduce the degree of pressure to promote integration and reflection of self-interpretation.

### ***Continuous Change: constant rotation of belt***

The belt's continuous movement was used as an interaction to indicate instant progress toward the goal. Like the cassette reel, it visually expresses the progression that the music (main interaction) is playing which goes towards the end of the tape. As such, the part that reel quietly shows the progress in the same speed was inspired to put constant belt movement as one of the interactions. The gradual change of light requires a long time to see the temporal change towards the goal, and the belt's movements focus on the instantaneous flow rather than the overall change.

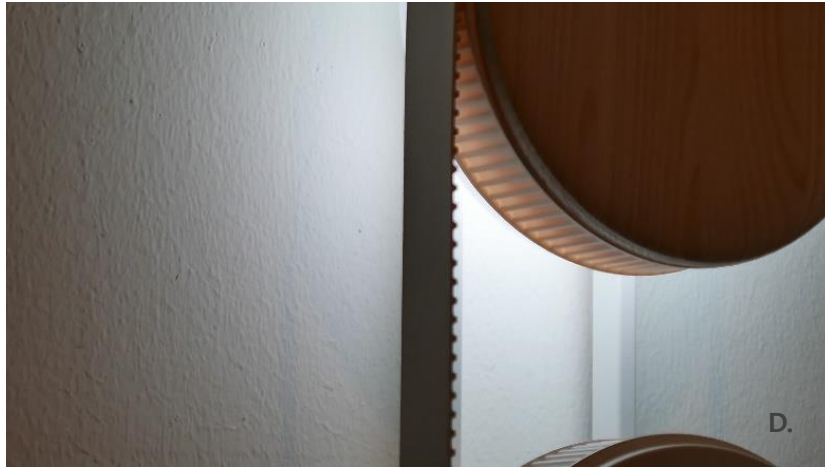
### **Usage of ReeLit**

When the user has come up with a goal to set, he/she can plug in the ReeLit's power. Then the light will brighten to maximum amount (Figure 34a). The user can take out the green button and open to write down the goal inside (Figure 34b). After writing, they he/she set the day by rotating the lid in clockwise. One big tick is one day, and one full rotation is 7 days (Figure 34c). The settable day is limitless. By waiting 5 seconds, the button will automatically return to the initial position and light will be in minimal size. The counting start from that moment. The light gradually brightens up and shows full brightness when it reaches the D-day (Figure 34d). The belt rotates continuously and stop when the D-day comes (Figure 34e). The user will see the brightest constant light until they set another goal by rotating the lid again whenever he/she wants.



**Figure 34 Usage steps of ReeLit. A) take out the button to write goal,  
B) write what you want to set inside the button,  
C) Rotating belt and gradual change of light until D-day.**





**Figure 354 Usage steps of ReeLit. D) Gradually brightens up until the D-day, E) continuously rotating belt that stops when the D-day comes.**

### 6.3 FUTURE STUDY

For the future study, explore more exposure methods and find out the interaction can improve process awareness and self-reflection when connected to another goal with weak motivation. One possible ways is through developed implication, ReeLit, in-field study can be conducted to find out 1) How far can it induce the users from the contemplation stage to action stage through continuous feedback in daily life and 2) How does continuous(belt) & gradient(light) feedback associated with a goal affect the behavior towards a short-term goal performance. To look deeply into the process of contemplation stage to the action stage and iteration, the duration should be longer than the previous study.

Moreover, with the different interactive everyday self-reflecting devices, we can discuss more about whether what elements in certain interaction can lead to the intensity of the motivation, expansion of various emotions related with intrinsic motivation, and what elements in interactions make the users to connect intrinsic or extrinsic reward with the device and behavior. Furthermore, we can analyze the pattern of attachment between devices and users and how it relates to behavior changes.

The value of this research can be applied in practical area to form a new educational device not only for the children but also for the adults who wants to push themselves for their improvement.

## Chapter 7

# Conclusion

### 7.1 SUMMARY AND CONTRIBUTIONS

As personal meta-data are presented in the forms of everyday things, the environment can be used as to naturally interact with these data to deliver extended value. These interactions can be engaged with self-related data and support awareness and understanding of their behavior in consistent way. Our research focused on how to deliver a goal related behavior data which was hard to perform due to the weak motivation. We proposed Bookly and ReeLit, self-reflecting everyday artifacts that expose process related data connected to user's motivated action and interact with users.

In the study of Bookly showed reading process through physicalizing pick-up time of on-going book with volume expansion. The Bookly's industrial design enabled careful delivery and positive interpretation of their reading pattern in everyday life. Over design iterations, we designed Bookly to highlight the book in progress. To make Bookly in harmony with users' real context, we went through technical development to construct well-balanced movement and increased the finishing quality. During 2 weeks of in-field study, Bookly has led to a natural perception of the users' reading habits.

For our findings, 1) Bookly naturally promoted self-tracking in reading through constantly offering reminders in their progress of reading. 2) This recognition drove the users to find a point to improve in their reading pattern. Moreover, this made reading to be a part of their routine and worked as a step to turn this short-term routine into a habit. 3) In addition, differentiating spot of a currently reading book increased its accessibility, and with accumulation the users received a small pressure with goal related message and facilitated concentration.

Through our discussion, we suggested several factors to be included in presenting self-reflective data for effective goal achievement. Expressing the amount of reading time in abstract visualization can easily lead to personal interpretation and reflects the subject's trials, effort, and attitude rather than absolute data. Exposing the progress related data with physicalization in everyday artifact has made it as a referent that symbolize the reading itself. It led them to constantly look back on their self-commitment and lead to gradual change.

For the design implication, we suggested several directions to design a self-reflecting object that expose abstract progress related data and merge the interaction with everyday object. ReeLit was one of the design implication development from groups of brainstorming which reminds unfulfilled thing

due to the weak motivation in everyday life through continuous belt rotation and gradual brightness change. Through these implications, we suggested further direction that might expand the iteration in action starting from contemplation stage.

Based on our design approach, this introduces a new space in expanding a self-reflecting everyday tangible device that promotes weak motivated behaviors that are difficult to perform. For the future research, with various interaction exploration of exposing abstract process visualizing device, attachment formation between device and user, patterns of intrinsic or extrinsic motivational connection with device can be studied to form a effective guide to design self-reflecting everyday artifact.

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## EXECUTIVE SUMMARY IN KOREAN

### 자기 표현적 데이터의 물리화와 그에 따른 행동 변화 연구 : BOOKLY 현장연구와 후속 연구

오늘날의 일상 생활을 자세히 살펴본다면, 몇 년 전 상상만 했던 기술이 자연스럽게 스며들어 있습니다. 기술의 개발로 일상 속에서 만들어진 데이터가 소멸되지 않고 해석이 되어 다시 우리의 일상에 또다른 역할을 차지합니다. 즉, 이전에는 어렵게 느껴지던 데이터의 개념이 이제는 우리들의 일상 속에서 쉽게 포착이 가능하며 그것을 가지고 다양한 방식으로 표현이 가능하며 어떻게 활용하느냐에 따라 새로운 경험을 전달할 수 있습니다.

최근 연구에 따르면 일상 생활 속에서 생산되는 자기 관련 데이터를 활용하면 행동에 대한 인식을 높이며 그 것이 반성 혹은 스스로에 대한 계획으로 이어지고 그에 대한 행동의 일관성을 유지할 수 있다는 가능성을 보여주었습니다.

이러한 배경을 통해, 우리는 동기가 약한 행동을 일상 속 어떠한 상호작용을 통한 개선을 다루고자 하였으며 그 행동으로는 독서를 선택했습니다. 이로 인해, 우리는 사용자의 누적되는 독서시간을 물리적인 부피 변화를 통해 생활 속에서 전달하는 아티팩트 인 Bookly 를 디자인하였습니다.

Bookly 는 책을 읽기 위해 쓰는 모든 시간을 담기 위해 책을 집어 올리는 순간부터 놓는 시간까지 Bookly 의 시간은 흐릅니다. 시간의 단위를 쓴 이유는 개인마다 책을 읽다가 생각하는 시간, 다른 책으로 바꾸고 싶어 무엇을 읽을 지 생각하는 시간 등 개인마다 달라질 수 있는 데이터를 활용함으로써 주체성을 가질 수 있게 돕고자 함이었습니다. 또한 Bookly 는 읽고 있는 책 만을 위한 공간을 제공함으로써 책장에 꽂혀진 다른 책들과는 다른 위치적 차이를 두었습니다. 이를 통해 위치가 주는 자신의 의지가 담긴 메시지를 강조를 하고 싶었습니다.

일상속의 Bookly 의 가치를 알아보기 위해 6 명의 참가자를 대상으로 2 주간의 필드 스터디를 진행하였습니다. 그 결과 일차적으로 물리적으로 표현된 지속적인 독서시간의 노출은 사용자가 자신의 불규칙한 독서 패턴 혹은 만족스럽지 않은 독서량을 인식하고 이해하는 데 도움이 되었다는 것을 알 수 있었습니다. 그것을 인지한 사용자들은 Bookly 를 통해 점차적으로 독서를 자신의 일정 속에서 어디에 넣을지에 대한 생각으로 이어졌고 독서 행동을 개선하도록 동기를

부여했습니다. 또한 읽는 중인 책의 독립적인 위치는 사용자가 책을 쉽게 들어올리고 읽을 수 있는 접근성을 높이고 심적 거리감을 좁히는 역할을 하였습니다.

즉, Bookly 를 통한 연구 결과에 따르면 약한 동기로 인해 수행하기 어려운 행동을 개선시키기 위해 자신의 의지와 관련된 무형의 목표 관련 데이터를 일상 속에서 물리적으로 전달하는 것에 대한 가능성을 확인했습니다. 그 이후, 이어지는 연구로 방향성을 제안하기 위해, 우리는 독서에서 더 확장하여, 약한 동기부여로 인해 수행되지 못한 일회성 계획을 다루어 보았습니다. 그리고 마지막으로 릴릿(ReeLit)과 같은 새로운 디자인 아티팩트를 통해 그와 관련된 의지 관련 데이터를 일상 속에서 또 다른 물리적 움직임을 표현하였을 때 예상되는 영향과 가능성을 제안하고자 합니다.

핵심어: 심리적 소유감, 디지털 음악, 재물질화, 감정적 애착

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먼저, 창의 디자인을 시작으로 지금까지 저에게 많은 가르침을 주신 박영우 교수님께 감사드립니다. 스스로에 대한 불확신이 있었던 시기에 저보다 더 저를 믿어 주시고 가능성을 알려주셨기에 제가 언제나 항상 웃으면서 지금까지 올 수 있었습니다. 교수님과 함께한 2 년이라는 석사 생활은 최적의 환경과 방향을 제시해 주신 덕분에 많은 성장과 생각을 할 수 있었고 멋진 경험으로 꼭 찰 수 있었습니다. 저에게 이 시간들은 앞으로도 많은 도움이 되고 다시 찾아오고 싶은 날들이 될 것입니다.

또한 저의 졸업 논문을 또다른 시각과 가능성을 제시해 주신 김항 교수님, 바쁘신 와중에도 따뜻한 웃음과 정성스러운 피드백을 주시고 학생들의 경험과 지식공유 문화에 신경 써 주셔서 저의 석사 생활이 더 풍요로울 수 있었습니다.

제 졸업 논문을 마지막까지 정성과 시간을 쏟아 주신 이경호 교수님, 항상 교수님과 함께 하면 에너지가 났고 무엇이든 해볼 수 있는 용기가 생겼습니다. 그래서 끝까지 힘을 내서 최선을 다해 졸업 논문의 완성도를 높일 수 있었습니다.

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육기철 선생님, 앞이 안보일 정도로 막막한 상태에서 905 에 찾아가면 선생님께서 손전등을 제 손에 꼭 쥐여주는 듯한 느낌을 항상 받았습니다. 항상 벽이라 생각하고 뒤로 주춤 했던 상황을 선생님께서 함께 고민해 주었기에 저의 석사생활이 발전으로 가득 찰 수 있었습니다.

또한 북클리와 함께한 3 년 내내 큰 버팀목이 되어준 이경룡 오빠, 항상 대화를 하면 연구가 재미있어지고 열정이 생기고 고민이 사라져 저에게 정말 큰 힘이 되었습니다. 그리고 존재 자체가 너무 큰 힘이 된 석사동기 최하연 언니, 항상 웃으면서 찾아와주고 힘들 땐 옆에서 혼자가 아니라는 포근함을 느낄 수 있게 해주어 덕분에 석사생활이 즐거움이 가득했습니다.

907 호의 큰 기둥이자 연구와 노력이 무엇인지 항상 옆에서 몸소 보여준 김준태 오빠, 보기만 해도 마음의 여유가 생기고 웃음이 지어지는 수빈이, 매일 많은 이야기를 해주고 연구상담도 잘 들어주는 맘이 따뜻한 장상수, 항상 도전하는 모습을 보면서 자극을 받을 수 있게 하는 멋진 김보민, 조용하지만 보면 분주하게 많은 것을 하고 있는 놀라운 김나리, 막내이지만 분위기 메이커인 문진영, 자신이 가진 색을 알고 그것을 확장하려 노력하는 김범, 졸업했지만 항상 도움을 주고 있는 든든한 보람언니와 경진언니에게 감사의 말씀을 전합니다. 그리고 내가 학업에

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**Investigating the Change through Physical Representation of Self-reflective Data:  
Field Study of Bookly and Further Implication**

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