A Study on 3D Interface Design in Mobile Device Environments with Screen Size Less Than 5 Inches

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Abstract: As the technology has been developed, display area of mobile devices is getting bigger than before and the trend indicates that the products with direct input method are preferred by consumers over the physical button type input method. Direct input method using fingers affects display interface design so new various interfaces have appeared. Especially, the issue regarding how to efficiently and intuitively use various functions provided on mobile devices has been addressed.

3D interface designs are also addressed from this perspective because it is believed that there is a possible way to efficiently display the contents while providing various functions on a small display. For this reason, this study was conducted to present graphic interface designs of display by researching on the possibility of 3D interface on mobile displays and to suggest the interface designs addressing the efficient information display on the display, which is regarded as an important advantage for 3D interface.

In order to fulfill the goal, four steps research was conducted including case study, base study, Idea Workshop for design proposals, and the results and suggested designs. Firstly, for case study, interfaces were analyzed by examining various mobile devices that provide mobile 3D interfaces. Secondly, for base study, the results of case study were examined and compared with the contents from academic researches on 3D interfaces. Thirdly, Design Idea Workshop was held based on the results gained from pilot study in order to get design proposals. The Idea Workshop was held targeting 13 graduate students majoring in UI Design that aims at allowing them to present their ideas by using image cards based on space perception cue, Z axis for the development of 3D interface, and gathering specific ideas about suggested frameworks including Interaction and IA. Lastly, new type of 3D interface graphic design and specific UI task scenario are suggested based on the proposals from the Idea Workshop.

The results of study indicate that 3D interface has advantages in displaying various functions on one display however, metaphor reflecting users real life experiences and reducing unnecessary transition for optimization are needed in order to apply the functions to 3D interface. This study has its significance as fundamental data for suggesting ideas and cases of 3D interface on mobile devices.

Key words: 3D Interface Design, Mobile Device, Idea Workshop

1. Introduction

Depending on the intended use, mobile devices are produced by dividing into several devices such as mobile phone, camera, music equipment and others. Recently, however, convergence, which can use all the functions in one device, has been provided as a default option. As finger touch is recognized, screen of mobile device has changed into multiple domain where display and operation are performed at the same time by including the function of physical button in the display area. Compared with the indirect input by using a physical button, the direct input interface by using a stylus pen has the advantage that it is possible to have quick access to functions users want and quickly input.

In addition, a larger screen area enables interface design of various concepts. Other than the functions provided by the manufacturers, it is necessary to cover this when designing the screen interface of mobile devices because users can download the content they want according to convenience. As for the functions consisting of icons,

Apple Inc. provides access to functions users want by using the finger slide. Although Samsung Electronics which applies the Android platform also provides functions user want by using the sliding type, it provides a function to make it possible for users to see what they want (such as clock and weather) in the background by using a technology called widget. Moreover, various interfaces are adopted to provide information effectively in various platforms such as Nokia Corporation whichuses Symbian platform.

Figure.1 examples of different Interface of the Platform

3D interface is also a type of interfaces provided by many mobile devices, and has been slow to expand due to excessive use of memory resources compared with 2D interface. However, it is considered that this problem will be soon solved when judging from the pace of technological development. From the effective presentation of information and visual aspects, it can be expressed in different perspectives. Therefore, this study aims to place an emphasis on the effectiveness of information provision and possibility to express various designs of 3D interface. For this purpose, the study was divided into four main phases: case research on ongoing 3D interfaces, basic research investigation, idea workshop and design proposal. First, interfaces were analyzed by investigating a variety of mobile devices providing mobile 3D interfaces. The basic research investigation proposed an academic basis of the interfaces examined in the case research through academic research on 3D interfaces
This study proposed a new 3D interface graphic design and specific UI task scenario by holding a idea workshop based on these results.

2. Background Research of 3D interface

2.1 Research on Current Examples of 3D Interface

Mobile devices have their own specific platforms. As of 2013, 6 platforms are produced. The interface design provided by Apple Inc. is a 2D type that uses several functions in the form of icons with the use of slide gesture, and it is less flexible to suit users' preferences. On the other hand, Google's Android is highly flexible to select or change interfaces according to users' preferences. Representative products can be Samsung Galaxy and HTC products. Although they have used the same platform, they have different identities in screen interfaces from each other. Symbian is a computing platform developed for mobile phones by Symbian Ltd., is a 32-bit multitasking operating system for real-time processing and supports 2G and 3G networks, mobile information profile and Java. Although it accounted the largest share of mobile operating systems as of 2009, the recent share has sharply dropped compared with IOS and Android. Maemo is a mobile phone platform developed to compensate for the shortcomings of Symbian and based on GNU/Linux OS and GNOME Desktop. It made

development environment easier for developers. In addition, there are RIM OS, which is famous for BlackBerry platform, and Microsoft Windows Mobile OS. Mobile device manufacturers that cannot have particular platforms as Apple Inc. determine platforms and then form interface design. Therefore, as for the screen interface, the processable screen embodiment can vary depending on the technical specifications supported by each platform. 3D interface is officially proposed as touch interface appears. This is because it is possible to input directly by finger although it was difficult to move from one space to another in the past. 3D interface can be realized after being designated as a default interface from the very beginning and be installed in users' devices after downloading. A representative example can be 'SPB Shell 3D', which is available for purchase on Google Play. Other examples can be TAT's FUSE, RedDish and LG's Areana, a discontinued model.

The 3D interfaces mentioned as an example make users feel sense of space by providing the *z*-axis in a screen. Such clear space classification increases efficiency of information recognition by making it easy to arrange and divide information by space and provides visual pleasure in use by giving motion when transitioning through space.

SPB `Shell 3D`

TAT `FUSE`

LG `Areana`

Figure.2 Example of 3D Interface of Mobile Device

2.2 Cues for Depth Perception

In order to express a stereoscopic effect on the two-dimensional screen in the 3D interface examples of mobile devices, we find it necessary to understand space, the *z*-axis.

Cue of depth perception was first mentioned and conceptualized by Leonardo da Vinci and means geometric properties that make us perceive that two images on one flat screen perceived are divided into one panorama and another background or that one is located closer and another is located in the far distance. Thus, cue for depth perception is important because it becomes a cue to bring more attention to a certain image by making us perceive images on a flat screen as three-dimensional (Nakayma & Sliverman, 1986). Despite that stimuli were provided by the same paper or screen display were physically flat, some stimuli could attract more attention, and others could hardly attract.

1. Relative Size

Objects of the same size look smaller when in the distance. This is called relative size or perspective (Hochberg, 1978). The principle is that it is possible to make a rough estimate of the distance of the object by comparing the size of similar objects at short and long distances (Clark, Jackson and Cohen, 1996).

2. Interposition

An object at a short distance obstructs the outline of another in the distance. Although this is an effective depth

perception cue, this tells merely the existence of object and not the distance with it.

3. Linear Perspective

When the size of the object in the distance is fixed, the sight is inversely proportional to the object distance (Kantowitz and Sorkin, 1983). The distance between fixed points gradually appears to be smaller angle. For example, even though electric wires on both sides of the road are parallel to one another, they seem to be converge with one point with increasing distance from the eye. Therefore, the lines converging with one point are parallel to each other and become depth perception cues (Wickens, 1992).

4. Light and Shadow Distribution

Shadow provides some information on the orientation and three-dimensional shape of objects (Ramachandranm 1988). According to the change in shadow and the brightest part, an object can be seen different distance and size (Graham, 1965). When an object receives light from one direction, a shadow indicating the object's shape and direction appears and gives a three-dimensional effect to it.

5. Gradient of Texture-Density

Gradient is a continuously changing characteristic value ratio and extended stimulation. Surface of most objects is covered with remarkably similar texture and pattern. There is no gradient of texture-density when taking a close look at the surface with texture. However, it means that gradient increases in proportion to inclination.

6. Monocular Movement Parallax

When observer's eye moves related to the environment or in the opposite case, different angular velocities exist between sight of a fixed object and that of another object. For example,

it means that an object in the distance moves in the direction of an observer while another object at a short distance moves in the opposite direction of the observer (Graham, 1965). It is possible to make a rough estimate of the distance by observing the moving amount of the given images and relative directions (Clark et al, 1996).

7. Familiar Size

In order to estimate the relative size, familiar size of objects is available. For instance, we know that adult males are taller than boys. When the images on the retina are of the same size, it is possible to expect that the adult male is located farther than the boy.

3. 3D Interface Idea Workshop of Mobile Device

In order to propose various designs of 3D interfaces with a screen of less than 5 inches, this study held an idea workshop with the use of the picture cards based on the space perception cues of the *z*-axis covered in Chapter 2. As a result, it derived the specific idea of interaction and Information Architecture.

3.1 Participants in Idea Workshop

The idea workshop was held for 13 graduate and doctoral students majoring in interaction design in a total of 4 groups.

3.2 Standards for Idea Derivation

In order to express3D interface design that can be represented on a 2D screen, the concept of space (the *z*-axis), as an idea, this study held an idea workshop based on the images by using picture cards with the examples of the depth perception cues covered in Chapter 2. Based on the monocular parallax caused by experimental factors among the depth perception factors, the depth perception cues were set and 25 picture card suitable for each cue were prepared to provide a total of 150 picture cards. In order to express more specific ideas, the components of

particular interface were used as a standard.

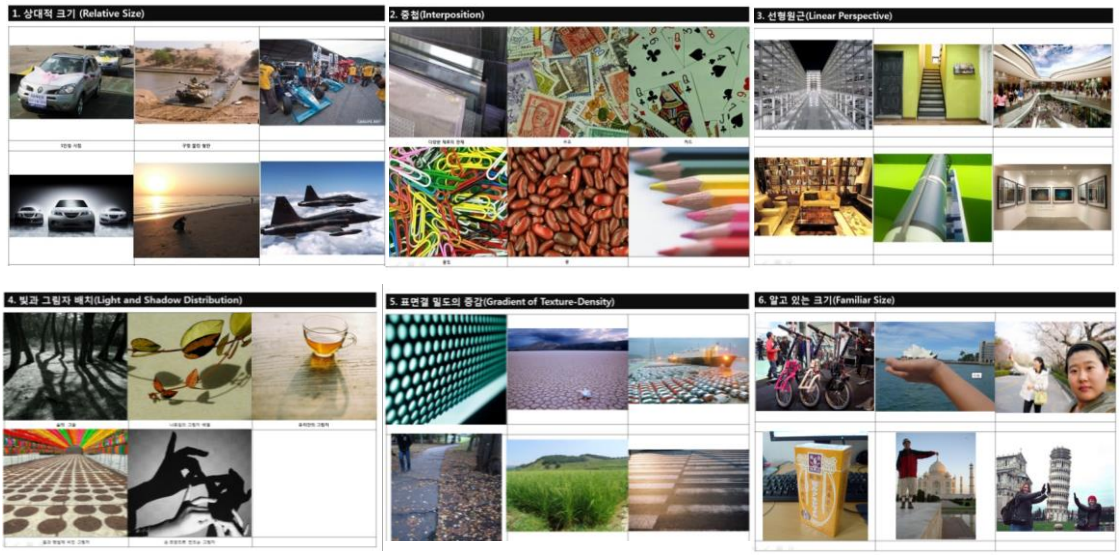


Figure.3 Examples of picture cards for depth perception cue provided in workshop

3.3 Idea Card

The idea card provided the framework by constituent element so that it was possible to describe the characteristics of the whole idea and main explanation by screen and was produced so that it was possible to visualize and describe ideas.

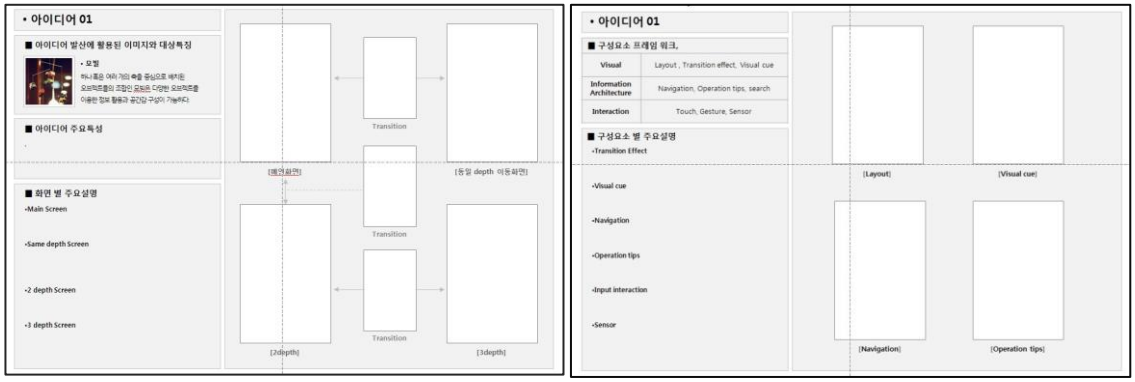


Figure.4 Idea Card

3.4 Process of Idea Workshop

Ideas presented by the idea workshop were produced as a paper prototype for specific expression. It is considered that this played a role as a catalyst sharing ideas between participants and then the ideas could be developed more.

Brain Storming

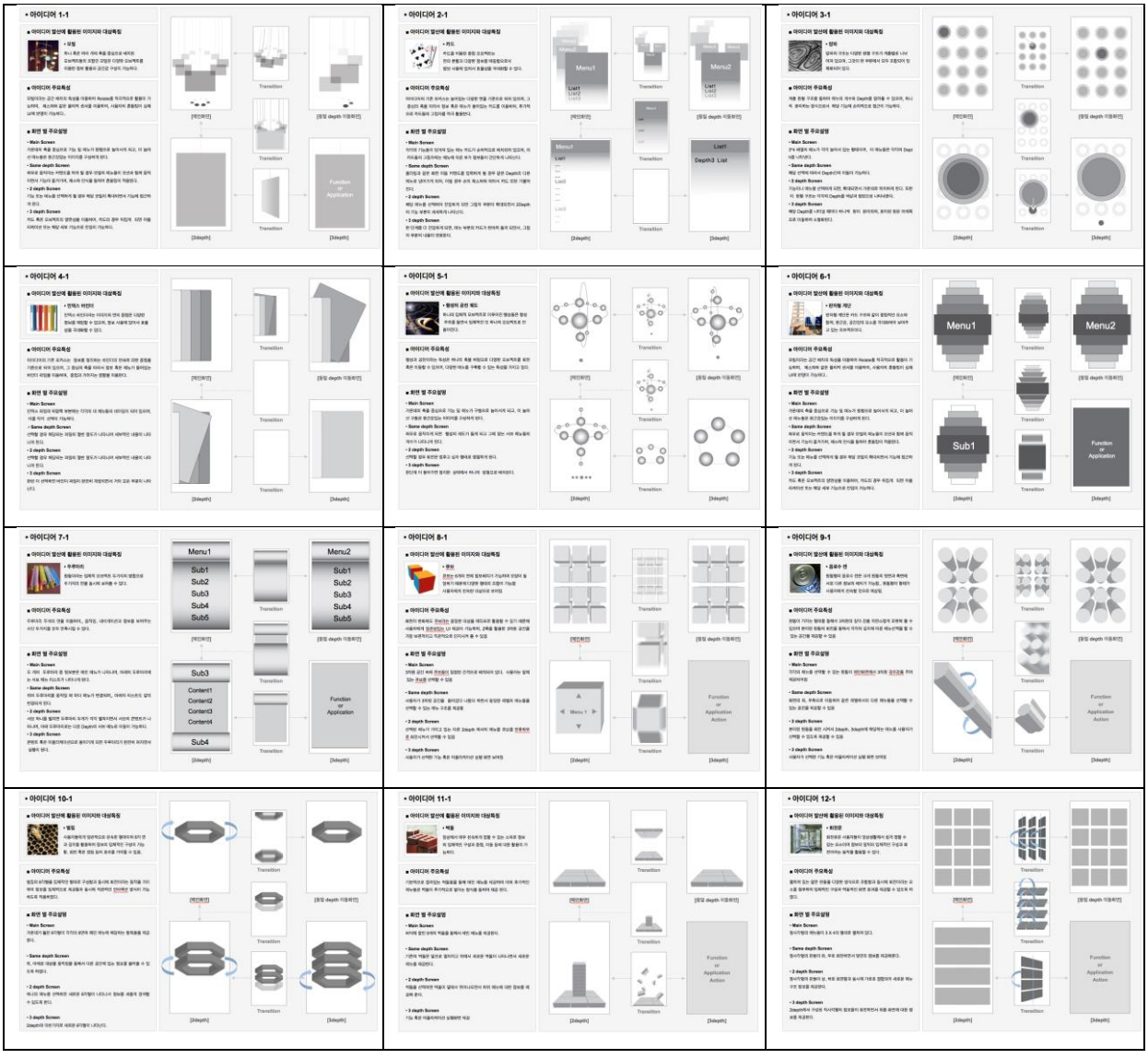
Share & Presentation

Figure.5 Idea Workshop

4. Result

4.1 3D Interface Design proposed by Workshop

More than 60 3D interface designs out of 4 groups were proposed by the idea workshop. Except for similar ideas, a total of 18 designs were summarized in Figure 6. 2 ideas were developed to select the Task and specific Use Flow was also developed. This study selected the most fundamental mobile functions, photo album and address book.



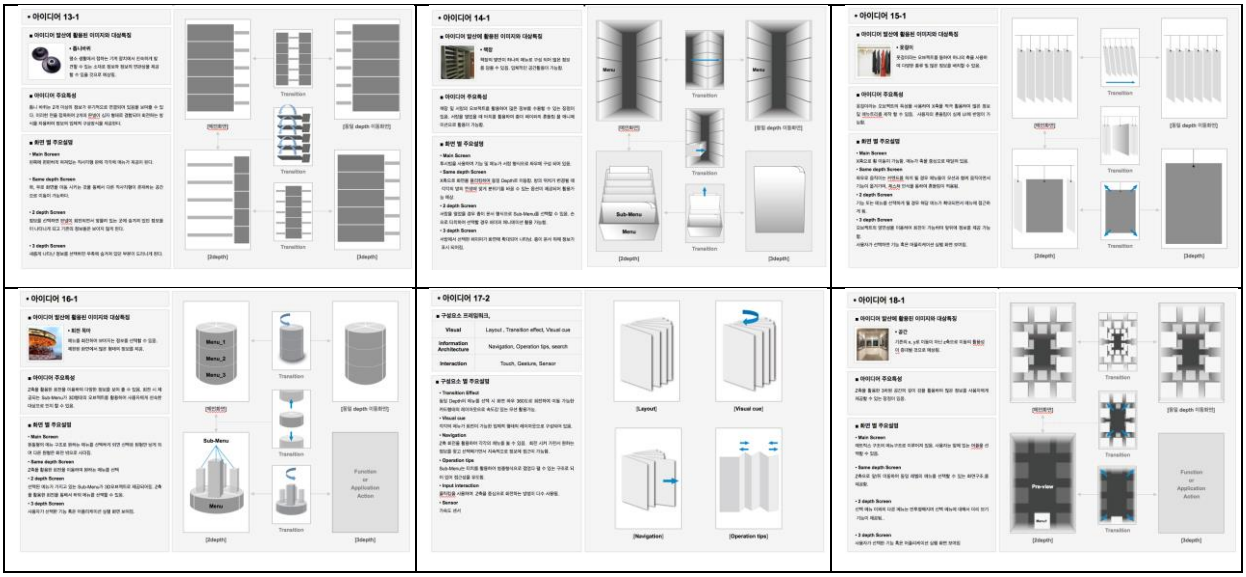


Figure.6 idea Workshop Results

4-2 Task Definition and Design Realization of Mobile 3D Interface

Table 1 is a specific description of the functions of address book and photo album to be realized in this study. Based on this, this study designed users' Use Flow in detail and proposed the final 3D interface design.

Table 1. Description of Main Menu

Task	Function	Description
Address Book	Detailed View	When selecting the data, it is possible to view the address book data in detail and edit them.
	Search	Difficult data to search sorting by group/time ordering can be found by direct input through searching.
	Add	Inputting and saving data into address book additionally.
	Delete	Selecting the previous data to delete
	Sorting	Sorting by group/time ordering helps users search for the data in address book easily
Photo album	View	Group and individual views are provided in the same manner as viewing photographs.
	Edit	A simple editing is possible by providing a simple editing function to copy and delete photographs.
	Transfer	It is possible to transfer to E-Mail, MMS (Multimedia Messaging Service) by attaching photographs and content.
	Background	Desired images can be set as a background of users' mobile phones.

1.Final Draft Design of Address Book

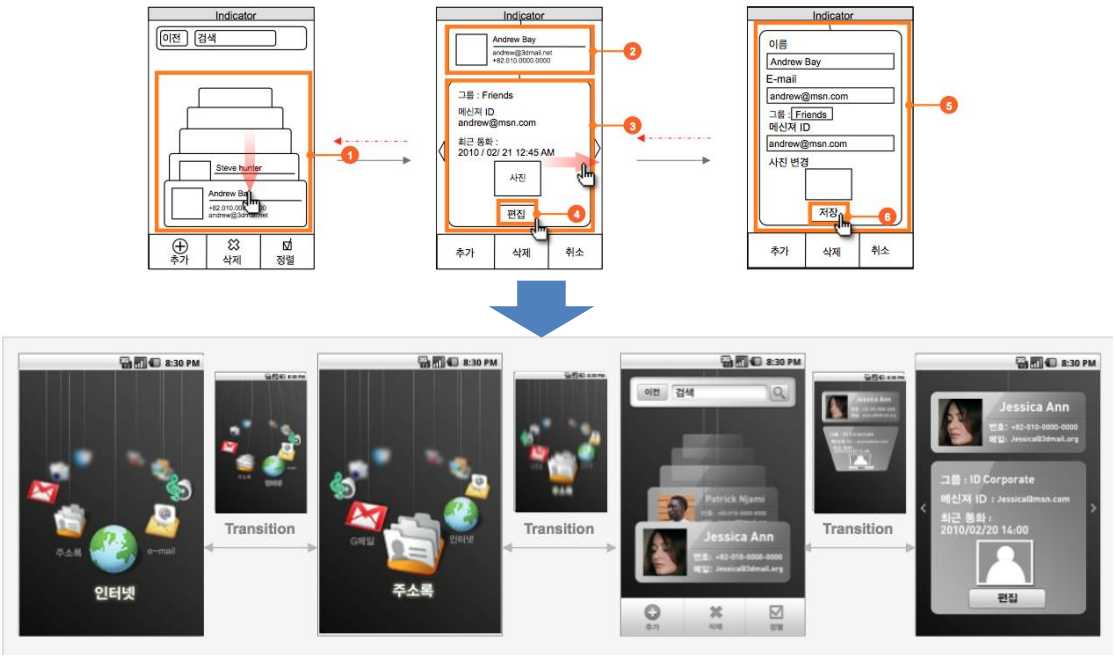


Figure.7 Draft design and final design of address book Use Flow

2. Final Draft Design of Photo Album

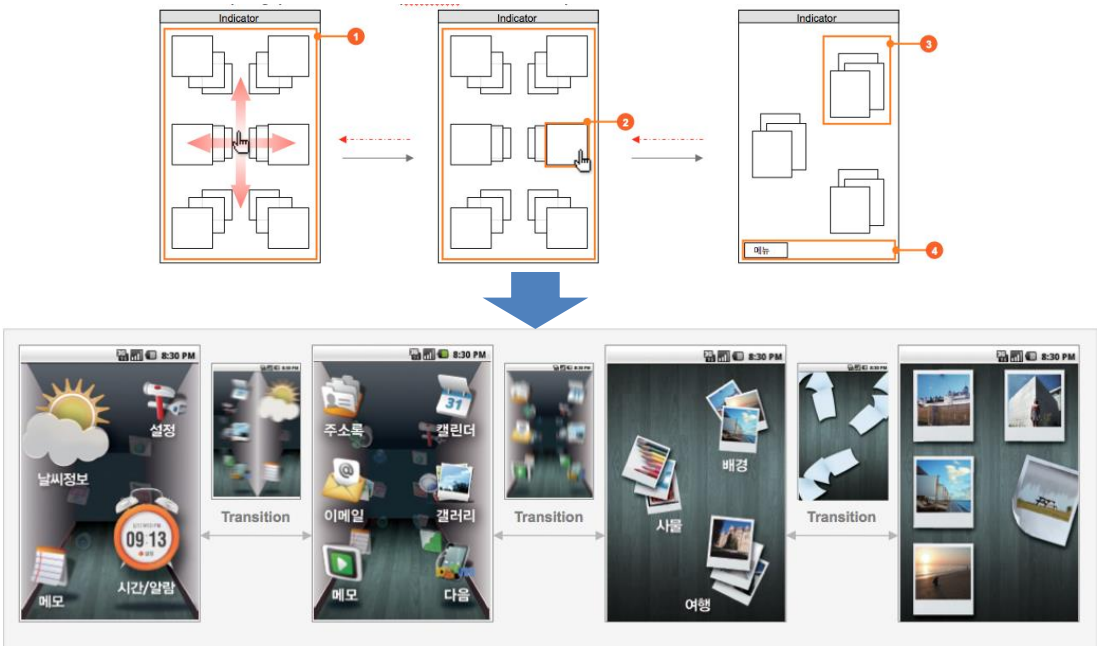


Figure.8 Draft design and final design of Photo Album Use Flow

5. 5. Conclusion

Different patterns with same colors or patterns with large sides displayed a big difference from things like character association effects. Even products with the same shape can achieve different impressions through slight changes and this can prolong the life of the product or offer various experiences and emotions to the user.

Although this research only evaluated impressions of color applied samples to patterns manufactured by other people, if expressing your own characteristics by personally making or mixing samples becomes more common we expect a new cultural trend where many users of a same product use it diversely and widely. As products shapes became simpler stickers, cases, and character accessories were used only to simply distinguish from one another until now, but in the future we believe that user participation will become more active and diverse. Also currently the front sides of mobile digital devices are changeable anytime by changing the wallpaper but the backside still has difficulty. If devices in the future become transparent screened with more developed technology or if the backside is also able to express digital images like the front side, then we expect that self-expression through the product perceiving the user's circumstance will be possible.

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