Designing for Profound activity :

Learning Photography by using digital camera

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Chair of supervisory team: Prof. Dr. Pieter Jan Stappers
Mentor of supervisory team: Dr. Stella Boess
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Contents

Abstract

Since the complexity of digital technology inside electronic products went beyond normal users' intellectual capability, interface design means allowing users to perform tasks without understanding how technology works. Consequently most current digital products are filled up with decision trees and menu structures providing functionality without showing what happened inside – so called the featurism of electronic products. As a counteraction to the featurism, products has started gaining additional layers of interface – e.g. 'quick launch button', 'interface wizards' and also 'character agents' – which makes the products looks simpler and smarter. As more layers are added on user interface, more operations are automated into one functionality and hidden behind the user-interface, thereby users can't even aware of them. I raise a drawback of the approach in the specific product domain – *Products for Profound activity*.

Opposite to *Shallow activity*, Profound activity evolves user's expertise, thus a user would want to be an expert while doing it. Profound activities often have intrinsically unpredictable goals, especially when the activity demands user's creativity, and it prevents automation from going too far.

When the interface is designed for shallow activities, it's easy to learn, quick to use, but has restricted possibility, while a product with profound activities takes longer time to learn, but has wider possibility. Based on it, the design goal of this research-through-design project has been drawn – Improving a smooth pathway from **shallow activity** (easy for beginners) to **profound activity** (useful for experts) on user interface of electronic product.

To put this research project within the theoretical context, two existing areas of research were explored: *Mental model* and *Learning by Using*. The research area of mental model concerns 'how product can support user's knowledge acquisition while using it'. Going deeper into user's knowledge acquisition, the area of Learning by Using states that daily products have both aspect of Learning and Using. Additionally, *Scaffolding with Fading* strategy supporting user's gradual improvement is introduced. The exploration ends up with an interaction model – *a pattern of reflective cognition caused by feedforward-feedback interaction* – which depicts how product interface evolves user's activity to profound one.

Getting deeper into Profound activity, digital photography was investigated by interviewing amateur photographers and observing photographic excursion. As result, three groups of photographic knowledge are defined: Aesthetic sense, Technical knowledge, Operational skill. The technical knowledge doesn't show up frequently at photographic moments, however, it connects user's aesthetic sense and operational skill while user's doing reflective cognition. By overlapping the interaction model and three groups of photographic knowledge, roles of feedforward-feedback interplay have been defined: in brief, the interplay interconnects the three groups with causal relationships.

An experiential prototype is designed and built through six phases of incremental development – starting with a conceptual model, ending up with an experiential prototype. The conceptual model depicts internal relationship between each element of digital camera interface, and is characterized in two aspects.

1) The internal relationship forms a network of controls and feedforward-feedback interplay.

2) The model is scaffolded in two steps.

The experiential prototype simulates photo-taking moments on PC monitor, and user controls it with mouse. Although it has some limitations caused by its low-fidelity - lack of tactility; lack of freedom in context; flaws in technical performance -, participants can adapt to the prototype quickly.

The experiment is set up to investigate how people interact with the camera and what they can understand during the interaction. Six volunteer has participated and each session was video-recorded. Their changes in photographic expertise were tested before and after the interaction, and compared.

The result of the experiment indicates that all the participants' expertise in photography have been improved while interacting with the prototype. The experiment also shows the prototype mainly influences on user's Technical knowledge and Operational skill, while Aesthetic sense was already mature in the opening test. The narrowed gaps between three knowledge groups prove that participants' photographic activities stepped forward to profound activity.

Finally the reflection on the work gives what knowledge has been gained in this research-through-design project and to what extent the knowledge can be generalized in the problem area – *Products for Profound activity*.

Firstly, the gained knowledge starts from an interaction model illustrating how feedforward-feedback interplays can evoke user's reflective cognition. The model is very abstract and fully generalizable in the problem area, but it also evokes further questions in detail.

The second knowledge is the knowledge groups in digital photography. Although the names of the groups are subordinated in the activity domain, their meanings can be applied to other cases.

Lastly the third knowledge, the conceptual model and also the prototype, is very specific to digital photography. Thus they can be an inspiration for other cases in the problem area.

0 Orientation

0.1. Introduction, problem area

Perhaps we cannot subdue the increasing complexity of digital technology. Thick manual books, numbers of buttons on remote controls, dozens of icons on status screen and also deep menu structures- those kinds of massive information exemplify how broad the gap between the physical world where we live in and technology inside the appliance is. Since the complexity went beyond normal users' intellectual capability, interface design means allowing them to perform tasks without understanding how technology works. Consequently most current digital products - such as MP3 players, ticket vending machines, and online booking systems - adopt PC-like interaction style –with decision trees and menu structures (Djajadiningrat et al., 2004) providing all the functionality without showing what happened inside – so called the featurism of electronic products.

Although the strategy has generated a lot of useful consumer electronic product designs, many problem also has occurred and they don't seem to be solved until now. A recent study shows that even experienced users of normal computer application spend 45% of time with confusing menus, indecipherable dialog boxes, and hard to find functions. (Ceaparu et al.,2004)

As a counteraction to the featurism, products has become look simpler and smarter with additional layers of interface – e.g. 'quick launch button', 'interface wizards' and also 'character agents' –, and it's still a dominant approach in designing electronic products.

In this project, I raise a drawback of the approach in a specific product domain. First, the product domain is electronic product for profound activity. Second, the drawback is concerned in user's learning in the activity.

0.1.1 Electronic products for profound activity

In order to make the design goal clearer, the product category has to be described in detail. Products are always for certain activity domains, and an activity has its own expertise. Some activities has deeper expertise that users put some effort to improve than other activities, see figure 0.1. To give an example, using a vending machine for drinks is an activity with very shallow expertise, while online booking system of flight tickets can be much more complicated one not because it has many functions but the activity can be improved fairly much by learning domain-relevant knowledge and practicing it –

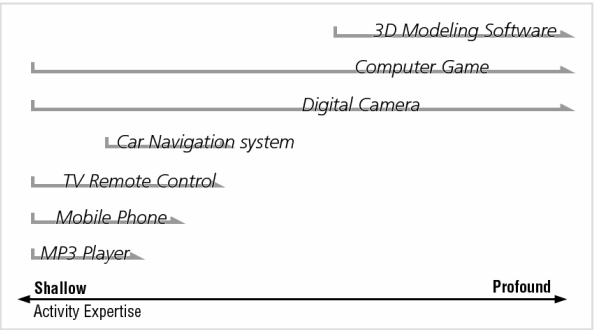


Figure 0.1: Depths of activity expertise with different products

therefore it's a profound activity. The easiest way to distinguish profound activity is imagining a person who can do it very well. It sounds strange if somebody says "I'm professional in listening MP3 music."

Since technology inside electronic products is incomprehensible, user interface provides direct controls to product's functionality. For example, calling a person with a mobile phone is done just by pressing a button, however, the button calls a set of operations inside the phone. As the operations are automated into one functionality and hidden behind the user-interface, user can't even aware of them. Products for shallow activity have higher level of automation than for profound activity.

	Products for Shallow Activity	**Products for Profound Activity**
Examples	MP3 Player, Mobile Phone, TV Remote Control	Digital Camera, Computer Game, 3D Modeling software
Strength	Easy to learn.	Broad possibility of activity.
Weakness	Restricted possibility of activity.	Long training time.
Dependency on context of use	Low	High
Level of Automation	High	Low
Technology inside the product	Both incomprehensible	

Table 0.1: Comparisons between Products for Shallow activity and Profound activity

A profound activity can't be highly automated for two cases. First, when an activity is so dependant on context of use that current technology can't handle it automatically, the activity can't be automated. Thus, in order to satisfy user's needs according to dynamic contexts, interface should provide more manual controls.

However, as technology develops, profound activities in this case tend to change into shallow activities. As an example, in the days of vintage cars, starting a car was much more complex and failure-prone, as a profound activity; it involved advancing and then retarding the ignition, adjusting the fuel mixture, repositioning the fuel jets, and possibly pumping atomized fuel into the induction manifold; it also involved knowing whether the car was fitted with coil or magneto ignition (Wheatley and Morgan, 1964). Thanks to digital systems applied in cars, now the activity has been abstracted into extremely shallow one without any critical loss of its functionality.

Second, profound activities often have intrinsically unpredictable goals. Especially when the activity demands user's creativity, interface should maintain wide possibility of activity. 3D modeling software and Computer games can be the example. Since automation simplifies user's activity, designers should consider if it still can satisfy unpredictable needs in creative activity.

Often there are products for a profound activity - but focusing on only the shallow parts of it. To give an example, digital photography is a profound activity, as we can learn and improve it, however most compact digital cameras have highly abstracted interfaces only for shallow activities. Thus users with those compact cameras can take nice pictures without any effort, but their photography can't be a profound activity.

0.1.2 An anecdote about digital photography

Last year, I have talked about photography with a friend, see figure 0.2. Although he wasn't satisfied with his photographs and had enough chances to explore more about the camera's potential, the interaction between him and his camera hasn't changed much.

Digital photography, as a profound activity, leads users to explore infinite possibilities on the activity level. For example, photography has social aspects; we try to take nice pictures, in order to see smiles of other people. Sometimes photographic activity has to be creative; we often try to take an original picture which can show own creativeness. When we take pictures for a personal documentation, good pictures can saturate our memory much more pleasant. Those are motivations for improving photography and also the reasons why we can't be satisfied forever with own photographs.

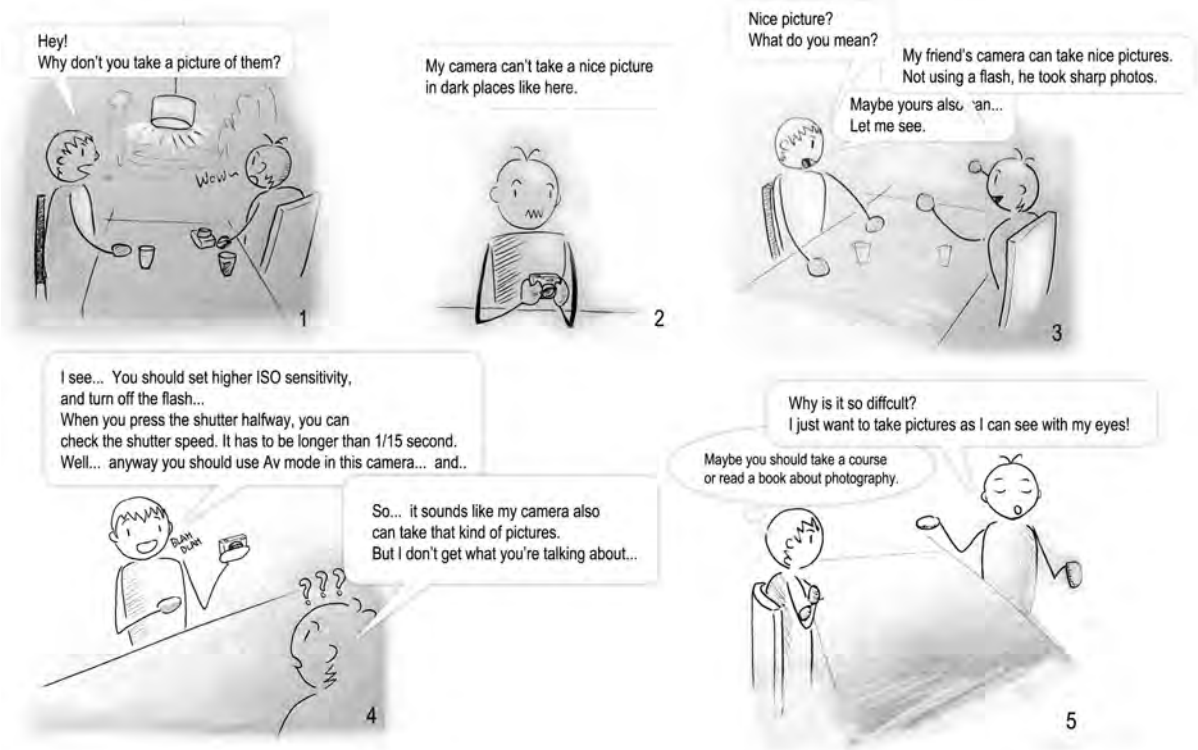


Figure 0.2: An anecdote of my friend about digital photography: Although the friend had been using his digital camera for two years, his understanding about digital photography had not been improved at all.

Since the current technology can't deal with various context of taking picture, there are still lowly automated controls for manual settings. In order to use those controls, user has to understand domain-relevant knowledge, and common ways of improving photographic skills are through external sources of knowledge – e.g. reading books or learning from other photographers. However, as a lot of amateur photographers are unwilling to put much effort in it, they just keep the simplest way of taking picture. In that sense, digital camera interface has an important role for enticing them into learning photography.

In the chapter 2, Digital Photography , more amateur photographers are interviewed and observed, in order to investigate long-term interaction with their own digital cameras.

0.1.2 Conclusion

An activity can be either shallow or profound, and to some extent, it depends on the interface of the product for it. When the interface is designed for shallow activities, it's easy to learn, quick to use, but has restricted possibility. To the contrary, a product with profound activities takes long time to learn, but has wider possibility.

Some activities, such as digital photography, are much dependant on context of use and also stimulate user's creativity – therefore they tend to become profound activities. On the other hand, learning profound activity is a too big burden for most beginners. Now designers are in dilemma – they have to design a product for profound activity but it has to be easy to learn.

Throughout this project, I try to build **a smooth pathway from shallow activity** (easy for beginners) **to profound activity** (useful for experts) **on user interface of electronic product**.

0.2. Approach, research through design

I've been trained as an industrial designer. Idea generation is my hobby, giving visible form to thought is my strength. Exploiting it, I follow research through design approach – which was coined *Action Research* by Archer (1995)*;*

Action Research: Systematic investigation through practical action calculated to devise or test new information, ideas, forms or procedures and to produce communicable knowledge. (Archer, 1995, p.6)

Therefore designing an interface for a profound activity is the practical action in this project and it produces communicable knowledge about design approach for a certain product group. While following research through design approach, there are two important things to notice;

First, the skills of the designers play an important role, it is through the designerly skills that the problem area unfolds. Second, the knowledge gained through a research through practice project is applicable to a specific situation. (Frens, 2006, p.28)

In this project, I frequently use common steps in design activity – inspired by observing people, generating ideas as many as possible, materializing and testing it. The knowledge gained through these steps is valid only in the problem area – electronic products for profound activity.

As the research through design process aims to produce new communicable knowledge, the design solution doesn't have to follow all the criteria in product development– such as being ready for production, aesthetically pleasurable.

Experiments in research through design is also a bit different from usability testing in early stages of product development process. For usability testing the prototype can be developed in service of many goals- to discover or refine user requirements, inspire or explore design ideas, share or co-develop designs with user participants, make a precise test of specific open issues, and share or deploy early implementation efforts. (Rosson, 2002, p.198) However, for research through design, the prototype mainly works for generating new knowledge, by answering predefined research questions. The knowledge that is gained leads to new theory or frameworks and is generalizable to a whole product category that is defined before starting the research project. (Frens, 2006, p.29) In sum, experiments in research through design focuses on very specific aspects of multiple products, while usability testing of product development process aiming at broad and open aspects of a certain product.

0.3. Research questions

Throughout this project, an alternative approach for designing interfaces of electronic products for profound activity will be developed. While doing it, five global research questions will be answered

1) Where is the alternative approach theoretically based on?

2) What are influential factors of the activity to the approach?

3) How can the approach be implemented as user interface?

4) What are the effects of the interface on the way of improving user's activity?

5) To what extent can the approach be generalized in the problem area?

The first question is answered by doing literature study in Chapter 1, Theory. The second one is answered in Chapter 2, Digital Photography, while observing and interviewing amateur digital photographers. In Chapter 3, Evolutionary development, the third question is answered. Chapter 4, Experiment, answers the fourth question. The fifth question is answered in Chapter 5, Reflection.

0.4. Structure

There are three categories of research activity in this project.

- PEOPLE : Investigating people in ethnographic manners.

- DESIGN : Generating ideas, Externalizing thought

- THEORY : Retrieving articles, Analyzing result and Drawing conclusion

In Chapter 0, the problem area is defined, and research questions are addressed. Chapter 1 explores theoretical issues about learning and embodied interaction. In Chapter 2, several amateur photographers are interviewed with their digital photo album, and also observed while traveling with friends. Chapter 3 is iterative cycles of designing a prototype and testing it. Along to the iteration, abstract ideas are embodied into an experiential prototype. In Chapter 4, the final prototype is experienced by 6 participants - beginners in digital photography. The participants are evaluated in their photographic knowledge before and after experiencing the prototype. Finally in Chapter 5, the knowledge gained through the whole project is reflected and discussed in terms of generalizability.

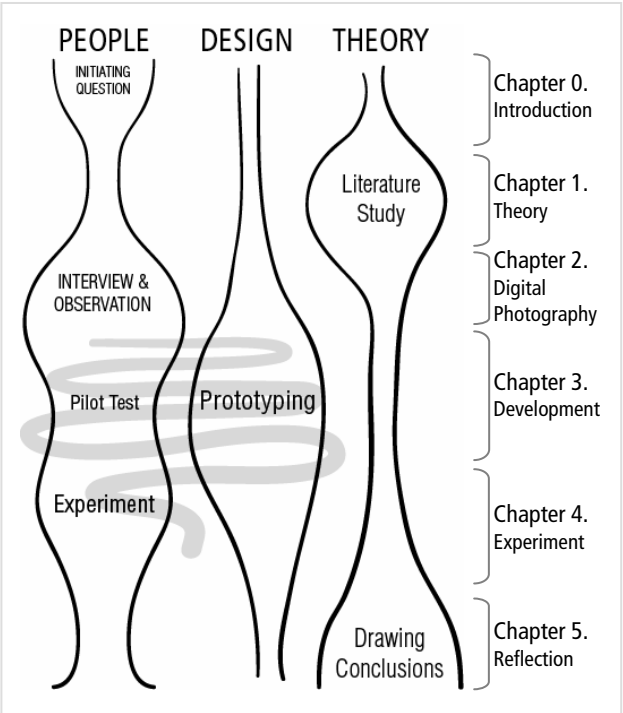


Figure 0.3: Structure of the project

1 Theory

1.1. Introduction

In this chapter I explore theoretical issues in HCI (Human-Computer Interaction) domain, in order to answer the research question - *1) Where is the alternative approach theoretically based on?*

As explained in chapter 0, the project focuses on profound activity and interaction between user and product for the activity, however, there isn't any single theory can cover the topic completely. Therefore I have to pick some ingredients from many theoretical issues, and mix them for my theoretical background. The issues are;

1) Mental model and Feedforward-Feedback interplay

2) Educational software – Learning by using

Finally I provide an interaction model depicting how user can gradually construct mental model of the product that leads to profound activity, with interplays of feedforward-feedback.

1.2. Mental model and Feedforward-Feedback interplay

As it's impossible to directly perceive technology inside electronic products, a role of user interface is to convey information about product usage to user. In this chapter, I briefly present some issues about the information and how the information can help user's mental model acquisition.

1.3.1 Mental model acquisition

While interacting with a product, users would acquire knowledge about its behavior, and on this basis they are able to develop theories about its inner workings. (Carroll and Olson, 1992) What they've formed about a working 'model' is called their *mental model* of the product. As formed from own experiences and observations on the product, user's mental model is based on the generated image of the product which Don Norman (1986) called the *System image*, and Preece coined the term, *Conceptual model*;

Conceptual model is a description of the proposed system in terms of a set of integrated ideas and concepts about what it should do, behave and look like, that will be understandable by the users in the manner intended. (Preece et al., 2002, p.40)

In the following chapters, I explore two kinds of information as a part of Conceptual model (or System image), in terms of their influences on user mental model acquisition.

1.3.2 Affordances : minimal information

Coined by Gibson (1986), affordances are possibilities of human's action in the context. To give an example, I can perceive a glass is graspable and possible to fill water in it, not because I knew it already but through the physical properties of it. Although well-designed affordances are crucial in user-interface where no intrinsic affordances exist, I would like to focus on what affordances can't afford.

While affordances provide a direct perception of what he/she can do with it, consequences of the action is still likely to be misunderstood or even incomprehensible. For example, some restaurants give a bowl of water on the table for washing hands. However sometimes the purpose of water could be misunderstood by foreigners.

When user can only perceive affordances, he/she would try acting on it and guess the consequence. Norman (1993) refers to

this as experiential cognition, which is fast and demanding little cognitive efforts. Reflective cognition, in contrast, takes longer to perform, requires conscious awareness and reflection, and involves making comparisons and decision making. Each style of cognition has its own suitable role, as below;

Whereas automatic, experiential cognition is valuable for performance-based tasks, it is not suitable for knowledge acquisition. Deep, insightful learning takes place through reflective and effortful thought. The more mental effort is exerted to "elaborate" a concept, the better it is learned. (Sedig et al, 2001)

In the light of the short discussion above, affordances are minimal information for usage, allowing user to act on the product. However when the activity involves user's learning, like profound activities, designers have to consider more information to be communicated. In the following chapter, an option for the additional information is presented.

1.3.3 Feedforward-Feedback interplay

Feedforward and feedback are common ways for connecting user's action to product's behavior in designing electronic products. While feedforward supports users expecting what will happen if he/she acts on it in advance, feedback gives product's reaction to user's action afterwards. A simple example of feedforward in electronic product is an icon printed on a button. While the physical properties of the button – as affordances - invite users to press it, the symbolic icon indicates what functionality is connected to pressing the button – which is a role of feedforward. For a simple feedback example, LEDs are often used for showing changes of states. Although these basic feedforwards and feedbacks are very helpful for designing intuitive electronic products, I would like to go further with them towards user's domain-relevant knowledge.

Here I propose an interaction model – a pattern of reflective cognition caused by feedback-feedforward interplay – in figure 1.1. In the model product's controls are surrounded by feedforwards and feedbacks. Before acting on a control, a user faces feedforwards and expects what will happen according to his/her current knowledge. After the action on the control, feedbacks show the result. If the result is different from the expectation, he/she would reflect on the activity.

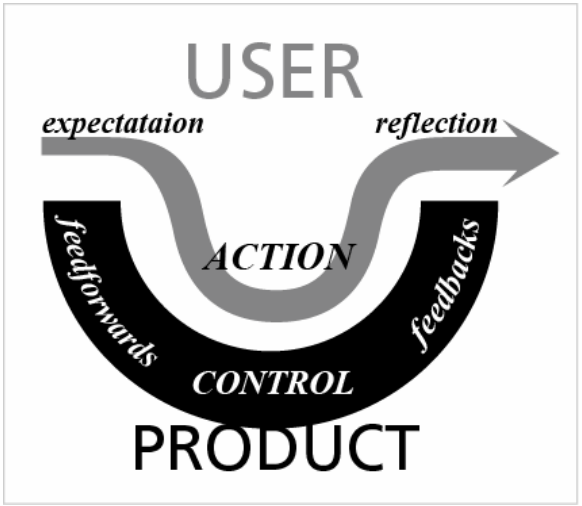


Figure 1.1 : a pattern of reflective cognition caused by feedforwards-feedbacks interplay : Controls in the product are surrounded by feedforwards and feedbacks – provoking user's expectation and reflection.

As reflective cognition evokes learning (Sedig et al, 2001), user would construct mental model about the control while acting on it, thanks to the interplay of feedforwards and feedbacks. In the long-term interaction with a product for profound activity, user's knowledge about the conceptual model would evolve gradually, as illustrated in figure 1.2. Therefore, in order to support the evolution, the interplay of feedforwards and feedbacks has to be changed gradually too. Theoretical issues about the gradual change is presented in the next chapter.

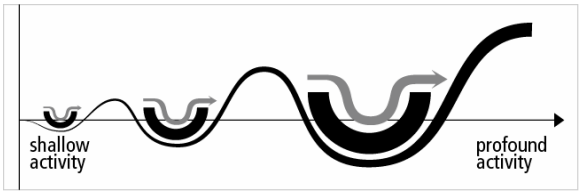


Figure 1.2 : Evolution of activity caused by reflective cognition

1.3. Learning by using

1.3.1 Tools for Living and Learning

Donald Norman argued in his book, The Invisible Computer, that each information appliance should be tailored to the specific task. As result, easy tasks can be done effortlessly but hard tasks may still be difficult. (Norman, 1993) His opinion conflicts with a common knowledge in educational research that admits learner's cognitive efforts as an indispensable factor in learning, as below; (Sedig et al., 2001)

While a lot of interface design research has been focusing on easy of use and intuitiveness as the ultimate goal to achieve, the aim of most educational software is not to optimize effort and speed up performance, but rather to engage the user in conscious attention to and reflection on the desired concepts being learned… (Ormrod, 1995)…Not only should the user interface be easy to learn and work with, but the system must also engage the learner in conscious construction of knowledge. For these reasons, the suggested guidelines and objectives developed by HCI researchers for the design of user interfaces may not all be appropriate for the design of interactive educational environments. (Rappin et al., 1997)

Broadening the scope of learning aspect, Stefan Carmien and Gerhard Fischer proposed a framework of Tools for living and Tools for learning, see figure 1.1 and 1.2.

Figure 1.3 : Tools for Living : are external artifacts that empower human beings to do things that they could not do by themselves. (e.g., a hand calculator). Tools for living can be tailored for specific tasks and for specific persons. (Carmien and Fischer, 2005)

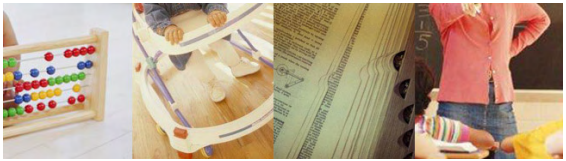


Figure 1.4 : Tools for Learning : support people in learning a new skill or strategy with the objective that they will eventually become independent of the tool. Tools for learning often serve a scaffolding function (Pea, 2004).

Misuses of Tools for Living can cause “learned helplessness” meaning that the ease and accessibility of using some of these tools inclines the user to not expend the energy and time to acquire these skills internally. On the other side, learning concepts in a particular knowledge domain with Tools for Learning takes relatively longer time and more efforts from users. (Carmien and Fischer, 2005)

Although the framework seems to cut all the products clearly into two extreme poles, a lot of everyday products are mixtures of both aspects. When a person buys any interactive tool for living (e.g. microwave oven) he/she probably tries to understand the usage of it by reading manual or interpreting affordances (icons, buttons, handles and so on) or simply trying it. After a while he/she will get stationary but sufficient knowledge and won’t feel any needs of Tools for Learning. Until he/she meets different needs which will call for Tools for Learning again, his/her pattern of use will be the same. This alternating pattern of using and learning is illustrated in figure 1.5. However it looks quite idealistic as the user doesn’t face any frustration or failure on the way of learning. As shown in the anecdote figure 0.2, user would have failed to achieve a certain goal and eventually wouldn’t try anymore. In that sense, we would be able to imagine a pattern of Using and Learning digital camera as illustrated in figure 1.6.

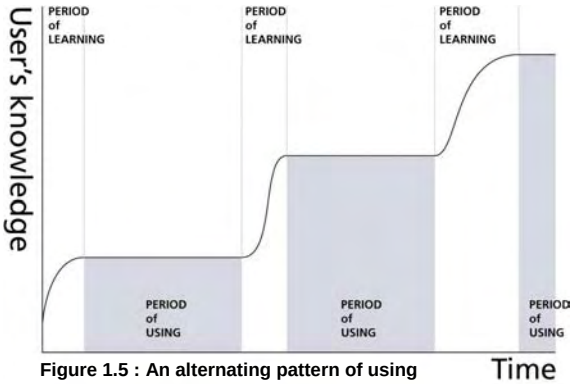


Figure 1.5 : An alternating pattern of using and learning in product usage

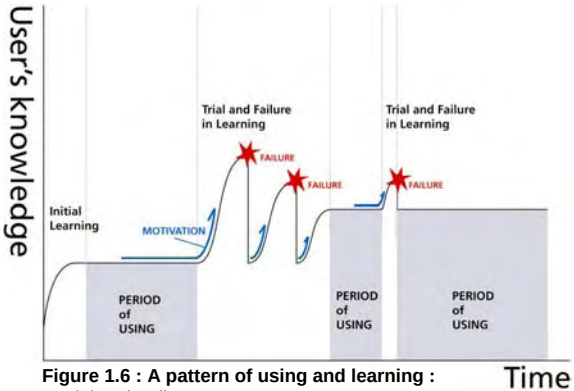


Figure 1.6 : A pattern of using and learning : a Trial-and-Failure case

Trial requires motivation derived from previous experience, but failure would weaken the motivation for learning. During the interviews with amateur photographers, presented in chapter 2, an interviewee witnessed a de-motivating failure, as below;

"For the first few months I had this camera, I've tried some further options for a few times. But most of them didn't seem work for betterment, and I haven't tried it again until now."

Without abundant external sources of motivation – such as clear goal, social responsibility or encouraging tutor – it wouldn't be easy to hold user's motivation for next trials.

To sum up chapter 1.3.1, Tools for Living and Learning, I want to emphasize that the two different aspects are existing together in products. In that sense, how to organize them harmonized with each other, in order to evolve the activity, is where my focus is on in this chapter.

1.3.2 Scaffolding with fading

In learning process, 'scaffolding' - *where the scaffolds are temporarily supporting users to rely during initial stages of learning a concept* - takes a central role of supporting a gradual transition from an intuitive stage to a reflective stage in learning. (Skemp, 1986)

Sedig et al. (2001) proposed a computer program for learning a geometric manipulation concept with a tangrams puzzle, see figure 1.7. While solving the puzzle, users can see the representation of the concept which is gradually degraded – from the left to the right diagram in figure 1.7. They have shown that this way of interaction can improve user's concept learning process while it takes longer to solve the puzzle.

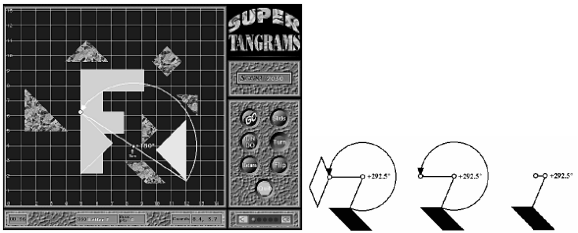


Figure 1.7: tangrams puzzle for concept learning:
The interface exploits "Scaffolding with fading" strategy to promote user's cognitive efforts step-by-step.

Shneiderman (2003) proposed a word processor with multi-layered interface where novice users can start at layer 1 with the simplest functions, and actively moves on to higher layers at any time, see figure 1.8.

In both cases, the interfaces gradually change shape according to user's progress, in order to show in-depth structure of knowledge and functionality. However, they have opposite directions. While the tangrams puzzle provides less information, the word processor reveals more functionalities as it moves to more advanced stages.

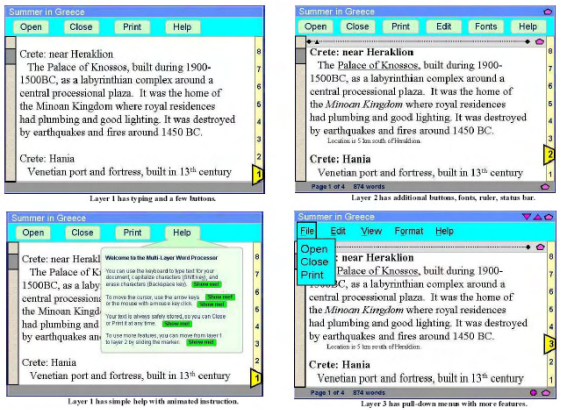


Figure 1.8: Shneiderman's multi-layered interface for word processing
: User can actively control the degree of functionality and information by using

There are many different ways of carving up the space of software scaffolds, and no common framework has yet emerged that can be used to provide design guidelines for scaffolded software. (Reiser 2002) Moreover, most experiments with scaffolding are conducted with PC applications which are in quite different environments from digital appliances in two aspects;

First, digital appliances have relatively limited resources for interaction comparing to PC applications. While users are interacting with PC software through mice, keyboards and big screens, with digital appliances, users can only interact with several buttons and small screens.

Second, using digital appliances involves much more dynamic context of real world than in PC environments. In particular, recognizing contextual factors is much trickier in real world than in virtual environments where most factors are already encoded.

1.4. Conclusion

Based on the presented issues, below I propose a simple scenario for the alternative design approach. The scenario is;

1) Interplays of feedforwards and feedbacks in a product interface evoke user's reflective cognition

2) Reflective cognition leads user's learning the conceptual model of the product

3) As the conceptual model being learned, user's activity gradually evolves into a profound activity.

Though the scenario seems very straightforward, still many questions are to be answered, in order to promote profound activity in daily use of products. As illustrated in figure 1.5 and 1.6, putting extra effort in learning isn't a common activity in daily use. Therefore, what interface can offer to users for reflective cognition during Period of Using can be a next question. Designing feedforward-feedback interplay can be another further question, as only when the interplay fits to the user's current domain-relevant knowledge and motivation, reflective cognition would be evoked.

Moreover, in order to promote a gradual evolution of the activity, how the interplay should be organized is also a question for following steps.

2 Digital Photography

2.1. Introduction

In the previous chapter I proposed a theoretical framework about long-term interaction between user and product for profound activity. Based on the framework, an analysis of digital photography, as an example of profound activities, is presented in this chapter. At the end of this chapter, one of the global research questions -*2) What are influential factors of the activity to the approach?* – will be answered by filling up the framework with instances of photographic activity. Therefore, finding out the instances is the sub-research question in this chapter.

instances are...

- Differences in domain-relevant knowledge among various expertise

- Motivations for improving photographic activity

- Structure of domain-relevant knowledge

Of course expertise in photography hardly can be discriminated between novice and expert, because evaluations on photographs can be very subjective. However, in this project, expert in photography doesn't directly mean a photographer who can take nice pictures or an optical specialist, rather I use the term 'expertise' as an ability for consciously dealing with influential factors in the camera and also the context, in order to take a picture as intended. Therefore a point-and-shoot photographer with genius artistic senses isn't regarded as an expert here.

2.2. Interview with amateur photographers

2.2.1 Research questions

Throughout this interview, research questions below are answered.

- What do amateur photographers consider while taking picture?

- What are differences between a novice and an expert in digital photography?

2.2.2 Participants

Total 5 amateur photographers (4 female / 1 male, ages from 24 to 30), with various expertise, have participated. All of them are students in TUDelft and there was no screening test. All of them are using their own conventional digital cameras and have photo albums in their personal computer.

2.2.3 Methods

The interview was informal and individually conducted. For each participant, it took from 45 minutes to 1 hour for two parts. In the first part – *Critics on example pictures*, 6 photographs were shown to them and they're asked to *1) evaluate it, 2) speculate how the pictures were taken, 3) how would they take pictures in the same situations*. See appendix I, to see what are the 6 photographs shown to them. For the second part – *Photo album review*, a set of pictures (containing 50 to 100 photographs) in their digital photo albums was reviewed. they're also asked to *1) explain how the picture was taken (in terms of camera handling), 2) remember what did they want to focus on in the picture, 3) choose the best 3 and the worst 3 pictures in the album*.

Entire interviews were audio recorded and analyzed with pictures afterwards.

2.2.4 Results

All the participants were very open in explaining their photographic activities with digital photo albums.

Critics on example photographs

While commenting on 6 photographs, each participant differently showed what to be considered in the situation and how he/she deals with them. For example, participant 1 and 2 criticized on figure 2.1.a as below;

[participant 1] "Auto-mode is good for this scene... But I would check the preview screen first."

[participant 2] "There are two ways of taking better shots in this backlight situation. The first is setting an exposure to the background, in order to stress the silhouette. The second is saving details on the face - but then the background will be over-exposed."

While participant 1 simply accepted the photographs as the only option for the situation, participant 2 saw two ways of taking picture and also pointed out how the results would be different. In terms of 'expertise', defined previously in this chapter, participant 2 has deeper knowledge about photography.

On figure 2.1.b, participant 1 and 2 commented as below;

[participant 1] "With the setting that my friend has set for me, out-door scene always have blue or violet tone like this. I don't know why..."

[participant 2] "... the strange blue tone which was certainly caused by wrong white balance..."

When an expert perceives a flaw in the picture, he/she connects it to his/her technical knowledge and makes alternative ways of taking picture in the same situation. Oppositely, a novice also can see the same flaw but can't figure out the reason.

Figure 2.1: Two example photographs shown to interviewees:
a. (left) This picture was taken under a typical against-light situation.
b. (right) Wrong white balance made the picture's tone blue.

Photo album review

All the participants had showed 50 to 100 pictures in their photo albums. As the reviewed pictures are original sets which hadn't been selected nor modified, participants were also reminded the photo-taking moments.

They talked about personal values on photographs (figure 2.2.f,g,h,i), good and bad appraisals on their digital cameras (figure 2.2.a,b), technical questions about photography, and most of all, memories about photographic moments (figure 2.2.c,d,e).

Figure 2.2.a: a bad appraisal on digital photography :
[Participant 1] "Monuments and structures are usually very big, but the scale is not fully expressed in these pictures. For me this is a frequent unsatisfactory aspect of photography."

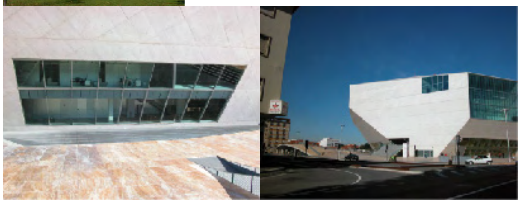


Figure 2.2.b: a good appraisal on her digital camera :
[Participant 5] "The weather was quite nice and I took many pictures of the river and the bridge. I think Nikon cameras have a bit calm and moderate tone than other cameras like Canon - I like those vivid colors."

Figure 2.2.c: Photographic moment _re-taking picture:
[Participant 5] "After I took the first picture, they said the faces are too dark, So I set a focus on their bodies for the next shot, then the background became too bright."

Figure 2.2.d: photographic moment _ re-taking picture:
[Participant 2] "In this series, I played with focus and depth of field. The first one is best for me."

Figure 2.2.e: photographic moment _ re-taking picture:
[Participant 4] "Here's the tree I like. At the second picture, I tried to catch the feeling of its curved shape, but it wasn't satisfactory. So I tried once again at the third pictures, it was quite okay. This picture has a different point of view from what I usually see with my eyes."

Figure 2.2.f: personal value on photographs :
[Participant 2] "I like this unusual picture most in this album, because it has beautiful tones and reminds me pleasure of the moment. I tried several pictures and this is the best."

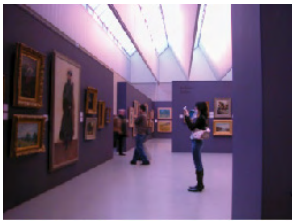


Figure 2.2.g: personal value on photographs :
[Participant 1] "I like this picture, because it contains a story. I was peeping into the doorway when she and the woman in the frame are looking each other."

Figure 2.2.h: personal value on photographs :
[Participant 3] "I like pictures with stories. These close-up pictures reveal unusual aspects I couldn't find easily in daily life. "

Figure 2.2.i: personal value on photographs :
[Participant 4] "I wanted to take a beautiful picture of these goats, but it's just a FLAT GOATS - which doesn't have depth, front and back elements. In my memory, they're so~ sweet, but in this picture mud and grass take my eyes. But I didn't expect really nice pictures, so it's okay."

Expertise evaluation

As addressed before, there's no common barometer for assessing one's photographic knowledge. However, the term 'expertise' in this project refers an ability for consciously dealing with influential factors in the camera and also the context, in order to take a picture as intended. In analyzing the interview results, each participant's expertise was assessed by checklists below;

- for each control of his/her digital camera,

~ Does he/she know in which situation the control is effective?

~ Can he/she estimate how it would affect on the result picture?

~ Can he/she operate the control at will?

The result, in table 2.1, shows difference of expertise between each participants. Participants 2 and 3, who usually use Program mode and Aperture-prior mode, are capable of most controls in their digital cameras. To the contrary, participant 1 and 4 merely can use flash and close-up focus options. Participant 5 is somewhere between them.

The result also reveals which controls are more difficult than others. As all the participants can deal with, flash and close-up focus controls seem quite easier than 'Selective focusing' and 'Half-pressed shutter > Re-framing composition'

Control *[description]*	Participant #				
	1	2	3	4	5
Camera mode for usual settings *[A: Auto / P: Program / Av : Aperture-prior]*	A	P	Av	A	A
Flash on/off *[if he/she could turn it on/off for desired effects]*	○	○	○	○	○
Close-up focus option *[if he/she could take a picture very close to the camera]*	○	○	○	○	○
White balance *[if he/she controlled WB for the natural tone of photographs under various lighting sources]*	X	○	○	△	△
ISO sensitivity *[if he/she could take sharp pictures under a low-light situation, by using higher ISO sensitivity]*	X	○	○	X	△
Manual exposure *[if he/she could manually control the exposure for intended photographs]*	X	○	○	X	△
Selective focusing *[if he/she could set focus on a certain object selectively]*	X	○	○	X	△
Half-pressed shutter > Re-framing composition *[if he/she understood AE/AF lock under half-pressed shutter, and use it]*	X	○	○	X	△

Table 2.1: An evaluation of participants' expertise on using own digital cameras : The mark '○' means the participant fully understood the control and also uses it purposefully. 'X' means he/she neither knows the control nor uses it.

In addition, participants with higher expertise use other modes than Automatic mode. Participant 3 said he usually uses Aperture-prior mode because it offers enough possibility in most situations. However, participants using Automatic mode have same reason for using the mode – they felt Automatic mode is enough in general.

Values on digital photography

During the interview, all the participants talked about why they took the picture, and what aspect they like (or dislike) of it many times. All they said reveals their values on digital photography.

Participant 1 said that she takes pictures in order to preserve precious moments, and a good photograph always reminds her the impression of the moment. [figure 2.2.g] Similarly, participant 4 pointed out many times feelings that she wanted to preserve in photographs, see figure 2.2.e and 2.2.i.

For participant 2 and 3 who have higher expertise, photographic values get more complicated. Participant 2 actively tried to create a desired impression by experimenting with controls of her camera. [figure 2.2.d] Moreover, participant 3 used photography as a means for creating a story. [figure 2.2.h] Higher expertise seems to be related with user's value on creativity.

Participant 2 and 3 also mentioned about social values of digital photography as quoted below;

[participant 2] "I'm happy when my friends are happy with my photos of them."

[participant 3] "Often I bring my camera to a party and take pictures of people eagerly. Next day, I send nice pictures of people and they would be happy with it."

Probably 5 participants are too small samples for drawing a conclusion on the overview of photographic values. However, it is quite clear that photographic values are the source of motivation for betterment in photography, and the basis of evaluation on his/her own photographs.

2.2.5 Conclusion

Considerations in photographic moments

During the interview, three groups of consideration were observed. Firstly, their personal values on photography are the starting point of photographic moments. Although it works very implicitly, the values determine what kind of photographs they want to take, and how photographs can be evaluated.

The second consideration is contextual factors of photographic moments. Lightings, object movements, moods (and so on) are all combined and considered by the photographer.

For the third group, photographers consider functionalities of their own digital camera, in order to take a desired photograph within the given context.

When these three kinds of considerations are abundant and well-balanced, the photographer is an expert in digital photography, who can consciously deal with influential factors in the camera and also the context, in order to take a picture as intended.

Differences between novice and expert

According to the concept of expertise which was defined in this project, an expert in digital photography is able to take picture in a wider variety than a novice. For example, an expert photographer knowing ‘selective focusing technique’ took many different pictures of one subject, see figure 2.2.d.

While novices prefer to use Automatic mode, experts use other modes providing more controls and also demanding more knowledge. Although most of participants have used Scene modes – predefined settings for certain situations. (e.g. Night shot, Landscape, Portrait and et cetera) -, none of them still use it regularly.

2.3. Photographic excursion

2.2.1 Introduction

Product usage can be seen as a situated activity prompted by what users encounter from moment to moment in a partly self-made context. (Suchman, 1987) Using digital camera is also an example of highly-situated activity where it's worthwhile to observe interaction between user and product in the context.

While in the previous chapter amateur photographers' considerations are investigated by reviewing existing photographs, here the photographic excursion focuses on observing photo-taking activities as a situated activity.

2.2.2 Participants

4 industrial design students (1 male / 4 females) have participated the excursion. Their ages are from 22 to 33, they are all intermediates in photography.

2.2.3 Methods

Basically, the excursion is a naturalistic observation. A hand-held video camera was used for capturing photographic moments during the excursion by the conductor. the conductor plays a participative observer role, talking and walking with participants but focusing on photographic moments. As this naturalistic observation didn't use Think-Aloud technique, individual retrospective interviews were accompanied by reviewing the photos and the video take the main role as a source of non-behavioral information. After picking interesting moments from the video records, the conductor met each of them and interviewed about the moment. Points of the discussion depends on research questions related to situations in the selected moments.

2.2.4 Research questions

The excursion aims to observe intermediates photographer's activities on the spot, such as;

- Physical interactions with own cameras in various contexts

- Social interaction among companions

In the retrospective interview, participants talked about their concerns at the moment. The concerns could be desired photographic values, difficulties, reasons for the action and remarks on the result.

By analyzing the video records and the interview scripts, three research questions will be answered –

1) How does one's photographic knowledge influence on his/her interaction?

2) Did they find any motivation for improving one's expertise?

2.2.5 Results

Physical interactions with own cameras

In terms of their physical interactions with own cameras, it was able to find out that few interactions are occurred with detail settings of cameras, see figure 2.3. Rather, they just move from position to position and change the orientation of their cameras regularly. Therefore serial pictures of a subject are varied in its orientations (landscape or portrait, see figure 2.4) or distances to the subject (a global view to close-up details, figure 2.5). Most interactions are through the LCD screen, the Shutter button and the Zoom control. It is interesting that they sometimes know how to take better pictures but just leave it in imperfection. In retrospective interviews, they said that it's because they don't want to spend extra time or efforts. Even they said, an excursion without a camera is sometimes better than carrying it and paying attention for taking pictures.

Figure 2.3: Leaving unsatisfactory result alone : *"I wanted to focus on the reeds, blurring out the boats in the background. I know how to do it, but everybody's walking on their ways and the subject wasn't very interesting. So I just left it alone.*

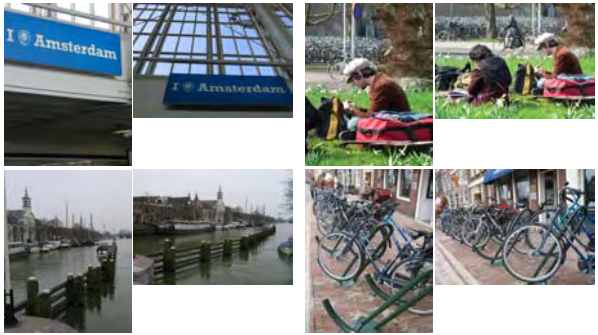


Figure 2.4: Portrait / Landscape variations : *For one subject, Portrait / Landscape variations are frequently used.*

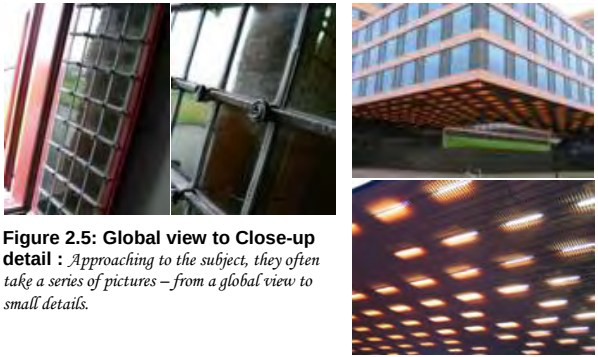


Figure 2.5: Global view to Close-up detail : *Approaching to the subject, they often take a series of pictures – from a global view to small details.*

Social interactions among companions

During the excursion, various interactions among companions were observed. It was easy to observe 'Me-Too photographers' which means a sigh of admiration can invite other companions to take a picture of the same subject. For example, if somebody said "it's so nice!", then others also tend to take pictures of same subject.

As all the companions brought own digital cameras, they took roles of photographer and model alternately, see figure 2.5. Sometimes one's photo-taking activity is also an interesting subject for other photographers, see figure 2.6.

Although I expected social interactions about photographic knowledge to be observed, they didn't influence on other's photographic activities in terms of settings or compositions. They've checked other photographer's pictures only when they had been photographed.

Figure 2.6: Being a photographer and a model alternately

Figure 2.7: a chain of photo-taking activity

When everybody has own cameras, photo-taking is also an interesting subject for photography.

2.2.6 Conclusions

During the observation and the retrospective interview, I found that photographic knowledge can be divided into three groups – Aesthetic sense, Technical knowledge and Operational skill; (see figure 2.8)

Three groups of photographic knowledge

1) Aesthetic sense

A photographer looks for an interesting subject and make the composition of photographs with his/her own aesthetic sense. After taking picture, his/her aesthetic sense is the criteria for evaluating their photographs and picking nicer pictures than the others. Aesthetics senses of a certain photographer are very unique, due to its strong dependency to his personal traits and values on photography.

2) Technical knowledge

This knowledge groups originates from internal mechanisms of photography. As the participants didn't talk much about technical knowledge, technical knowledge doesn't always make a direct influence on photography at the moment of taking photographs. It, however, helps the photographer to understand the technical side of digital photography, especially when he/she has a specific interrogation about it.

3) Operational skill

It refers a photographer's technique of controlling his/her own camera as his/her technical knowledge leads. To give examples, operational skills in digital photography range from very simple operations like 'turning the camera on' or 'taking picture' to complicate steps - 'changing white balance to fluorescence' or 'setting exposure brackets to -/+ 2 steps'. Supporting operational skill is a common goal of conventional interfaces of digital products.

In most photographic moments, looking for an interesting subject, setting a nice composition on LCD screen and pressing the shutter button at the proper moment, aesthetic sense plays a major role, while technical knowledge and operational skill have a little importance. Nevertheless, technical knowledge is always ready to be called for a moment when a photographer has strong aesthetic needs. In reviewing pictures after excursion, they evaluated pictures with their aesthetic senses and speculate reasons for some pictures which are different from their expectations with their technical knowledge.

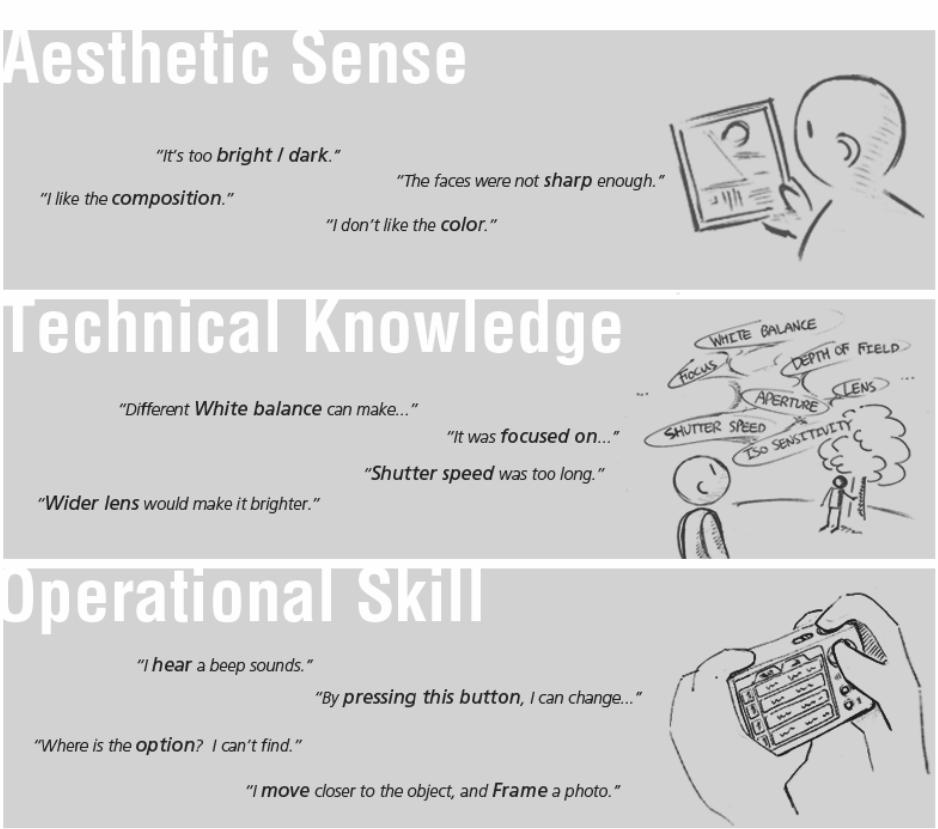


Figure 2.8: Three groups of photographic knowledge

2.4. Photographic knowledge within reflective cognition

Throughout the ethnographic studies on amateur photographers' activity, their photographic knowledge and considerations in taking photographs were investigated. The three groups of photographic knowledge – Aesthetic sense, Technical knowledge and Operational skill – are prerequisites for reflective cognition, introduced in chapter 1.

As illustrated in figure 2.9, in order to complete a cycle of reflective cognition, three groups of photographic knowledge work in turns. Here is an example taken from the photographic excursion;

"At the old toilet, the first shot was blurred because it was too dark. So I selected higher ISO sensitivity and took it again."

First, the photographer's aesthetic sense evaluated the previous photograph, and triggered the second shot. Second, her technical knowledge was applied for finding a reason for the previous failure and a solution for the next trial. Third, with her operational skill she navigates through menu structure and set the control as needed. After setting an option, she would check feedbacks if the setting was done correctly by using technical knowledge again. Finally, aesthetic sense is recalled again to evaluate the result picture.

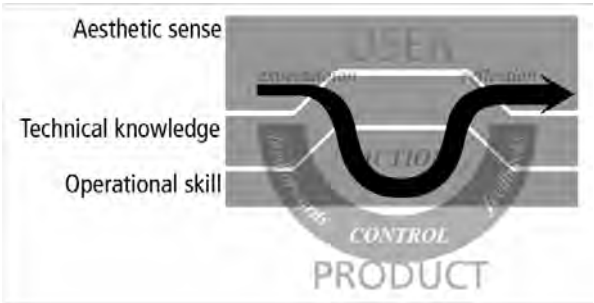


Figure 2.9: Three groups of photographic knowledge distributed within a pattern of reflective cognition
: User's reflective cognition is prompted by one's aesthetic sense. By using technical knowledge, he/she decides what to do, in order to satisfy his/her aesthetic needs. To act on the camera, he/she needs relevant operational skill. After the action, feedbacks of the action are interpreted by his/her technical knowledge, and the result is evaluated by aesthetic sense.

Roles of the feedforwards-feedbacks interplay

In the previous example, she already had enough photographic knowledge – aesthetic sense, technical knowledge and also operational skill. However, to promote a cycle of reflective cognition for novice photographers, interplays of feedforward-feedback have to perform several roles listed below.

First, feedforwards have to connect photographer's aesthetic sense to relevant technical knowledge. Otherwise, the photographer in the example wouldn't be able to notice shutter speed has to be shorten for taking clear pictures.

Second, both of feedforwards and feedbacks have to relate various controls in the interface. In the example, the photographer had to know he/she should set higher ISO-sensitivity to get shorter shutter speed.

Third, feedforwards should support photographer's operational skill while acting on the control as supported in conventional interfaces.

Fourth, feedbacks have to show what happened after the action, in order to support the photographer's reflection connecting his/her technical knowledge to aesthetic sense.

By classifying photographic knowledge into three groups, I suggested roles of feedforward-feedback interplay. Four roles of the interplay can't replace any knowledge group completely, but connecting all of them. (See the red boxes in figure 2.10) For instance, the interplay doesn't describe how the why high ISO sensitivity causes noise in the picture (technical knowledge), while it just exposes the causal relationship from ISO sensitivity to the image result – passing through shutter speed (connection from aesthetic sense to operational skill). Comparing to the photographic knowledge taught from books or educations – where practices are completely based on the theory -, the interplay promotes a personal and experiential way of learning.

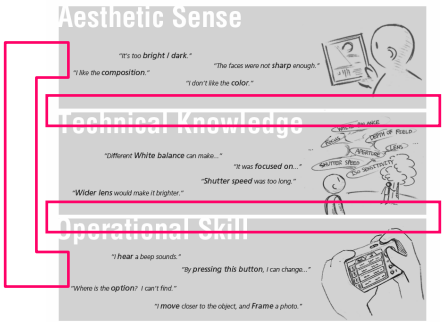


Figure 2.10 : Roles of feedforward-feedback interplay on three groups of photographic knowledge

3 Evolutionary Development

3.1. Introduction

3.1.1 Evolutionary development

Evolutionary development is an approach to software design and development that moves through analysis, design, development, and testing in a tightly interleaved and incremental fashion. (Rosson, 2002)

This chapter focuses on developing a brand-new interface of digital camera. In the previous chapters, I presented an interaction model of reflective cognition and three groups of photographic knowledge supported by feedforward-feedback interplay. Thus this evolutionary development aims to answer *'How can the alternative approach be implemented as user interface?'* which is the third global research question.

During the incremental development of research prototypes, the prototypes are tested by co-workers and amateur photographers several time and redesigned, in order to explore design possibilities as broad as possible and to get more responses from users.

Incremental prototyping starts from the conceptual model derived from theoretical backgrounds, and ends up with an experiential prototype.

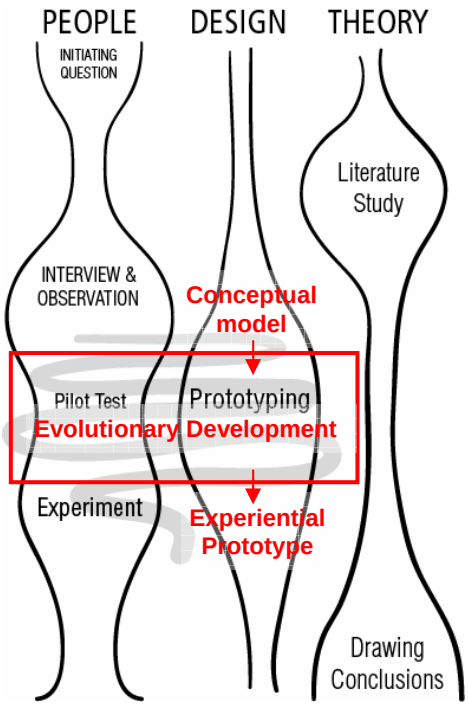


Figure 3.1: Position of Evolutionary development in the project structure

3.1.2 Overview

In total, 6 prototypes were designed. 1st and 6th design were tested by external participants and colleagues, while the other designs were tested only by the internal committee. (advisors of this project) See figure 3.1 to 3.6.

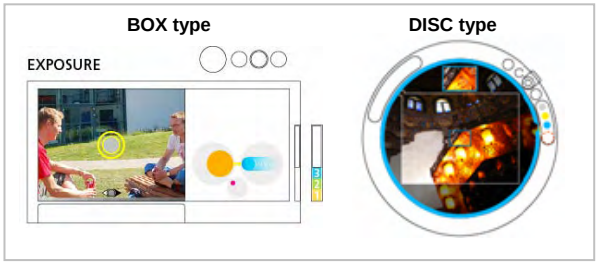


Figure 3.1: 1st design – exploring form-factors : Two types of physical shape of digital camera were designed and evaluated by the committee. Box type was selected to be developed further.

Figure 3.2: Paper prototyping of 1st design : With transparent films and printed papers, the 1st design was tested by external participants.

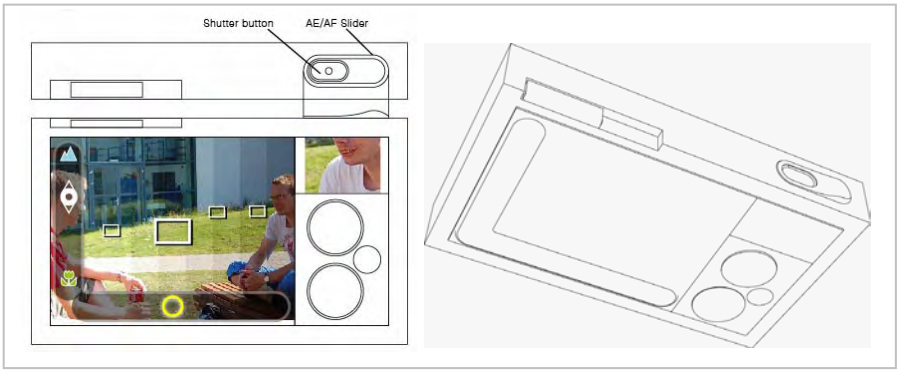


Figure 3.3: 2nd design

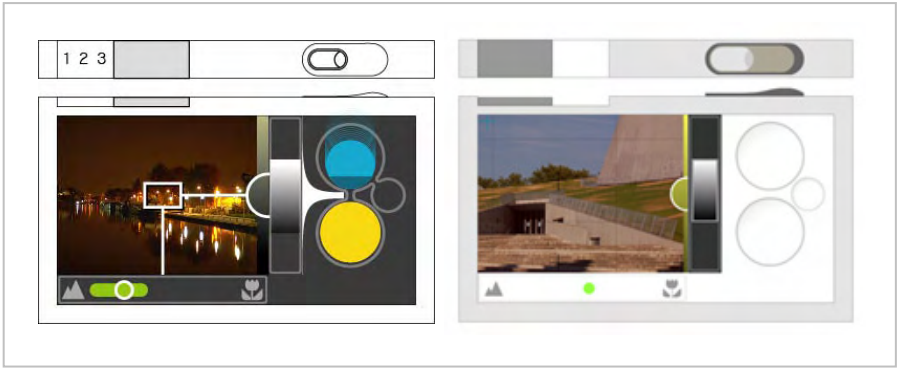


Figure 3.4: 3rd design : From 3rd design, partially-working prototypes were developed on the Macromedia Flash MX platform.

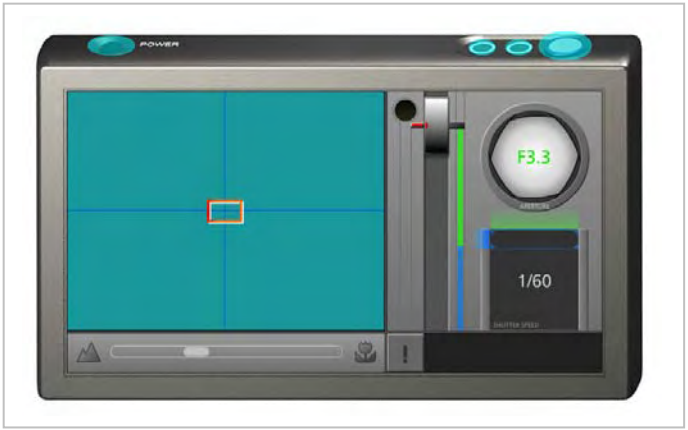


Figure 3.5: 4th design :
- Physical interface elements were redesigned.
- Representation style of body has changed into descriptive isometric form.
- Screen layout was revised again.
- Many ways for improving its usability have been proposed and dropped.

Figure 3.6: 5th design :
- The final version of experiential prototype started being developed.
- A pilot test was conducted and many usability problems were found

Figure 3.6: 6th design :
- Physical interface elements had been redesigned again.
- Picture materials for user test were collected.
- Details of Feedforwards / feedbacks were implemented.

3.2. Conceptual model

The aim of the experiential prototype is not just offering functionality but also promoting photographic knowledge. For that reason, a conceptual model has been developed beforehand, see figure 3.7. The conceptual model depicts internal relationships between each element of digital camera interface. All the elements exist also in conventional digital cameras but relationships between them are mostly hidden. In the following chapters, the conceptual model is characterized in two aspects.

3.2.1 A network of controls and feedforward-feedback interplays

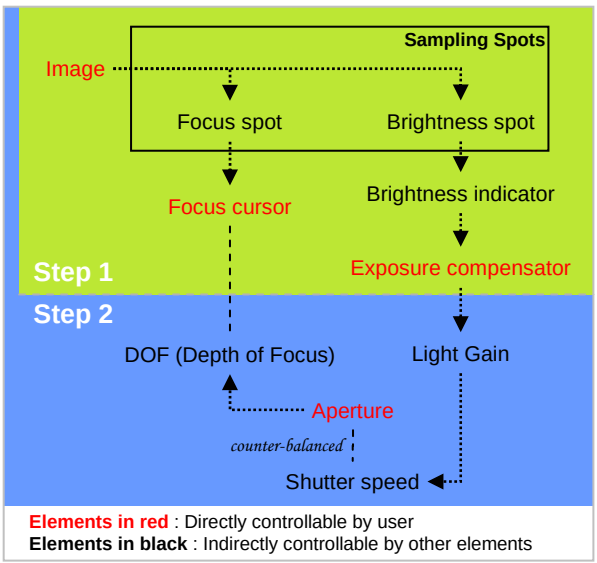
As shown in figure 3.7, some elements are directly controllable while others aren't, however all of them are clearly visible and connected to each other. As they're connected to each other, an element can have multiple roles – control or feedforward or feedback (illustrated in figure 1.1.) – according to the context. Moreover, user can notice easily incontrollable elements are able to be controlled by other controllable elements connected to them. The biggest advantage of the model is With visible connections among them, users are able to perceive how the internal mechanism inside digital camera works without any verbal instruction or external supports.

To give an example, when a user wants to remedy blurry image caused by too long shutter speed, he should shorten shutter speed which isn't directly controllable. However, if he had tried Aperture control before, he can easily understand Shutter speed and Aperture value are in inverse proportion, as they are interconnected through Light gain. In this example, the photographer has gained some valuable pieces of photographic knowledge – first, Aperture and Shutter speed together determine brightness of picture. Second, to shorten shutter speed, Aperture value has to be increased.

3.2.1 Scaffolding structure

To support user's gradual improvement, the conceptual model is divided into two steps. In step1, controllable elements are relatively simple and directly connected to user's aesthetic sense. Image, as a controllable element, is directly controlled by framing camera for setting desired composition. Exposure compensator would be understood as a control for changing brightness of the image, Focus cursor is for setting focus on a specific distance from camera.

Elements shown in Step 2 are extended from Step 1 elements. Light gain and Shutter speed are shown next to exposure compensator, in order to reveal further influences of exposure compensator. Aperture is added to provide as an independent control for changing shutter speed and DOF. I presume that users would be able to understand whole picture of the conceptual model while using this interface, and consequently their photographic knowledge will be improved.



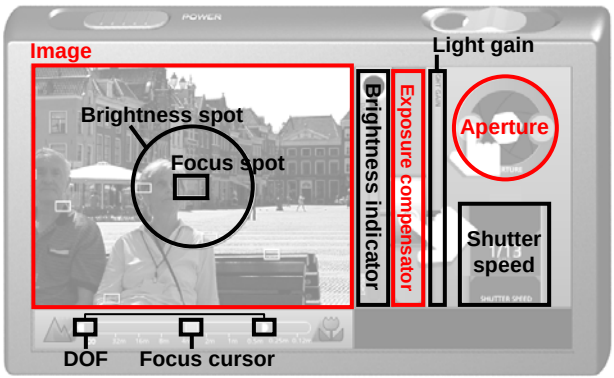


Figure 3.7: Dependence relations among interface elements : All the interface elements are interconnected by causal relationships – visualized by feedforward-feedback interplays.

3.3. Experiential prototype

3.3.1 Platform

As a result of the development, an experiential prototype has been made, on the Macromedia Flash MX platform. Therefore the prototype is only visible on PC monitor screens and users can interact with PC mouse. On the screen, user can see the backside of the camera (and the upside a little) which is almost covered with LCD touch screen of the camera where on-screen elements are controlled by mouse as if they're controlled by finger tips. Physical interface elements of the camera – Power and Shutter control – are also visible on PC monitor and able to be controlled by mouse.

3.3.2 Taking pictures within preset situations

The digital camera doesn't have any optical mechanism, however, it can simulate photographic activity with presets. The presets are series of picture previously taken from actual scenes with various focuses and exposures. Thus while using the camera, users can't see the actual scenery, can't change position but only can imagine they're taking photographs in the situation. Although user's can pan the camera, the angle is quite limited.

3.3.3 Limited functionality

As an experiential prototype for research project, the camera has limited functionality. For example, it doesn't have Zoom In/Out functionality, White balance control, Flash and many other minor functionalities.

3.3.4 Description, using the camera

When Power control is dragged to the right side, they camera switches on and display the image on the screen. While dragging Power control, user can see it has two steps of movement – a bit / completely to the right side. For each step, the screen gives a feedback with simple numbers – '1' and '2'.

To pan the camera, the preview image of the touch screen has to be dragged with mouse. When it's dragged, the camera doesn't actually move, but the preview image changes.

Step 1

To take a picture, user should drag Mode control to the right side, then Shutter button appears in the hole of Mode control.

When Mode control is at the left side, the camera is at the Automatic mode where Focus spot and Brightness spot, in figure 3.7, are actively analyzing the preview image and influencing on other controls. Thus, panning the camera in this mode causes changes of all other settings. Focus cursor isn't controllable in this mode. The automatic mode is similar to automatic modes in conventional digital cameras.

When Mode control is pushed to the right side, Focus and Brightness spots disappear and the camera doesn't react to changes of preview image – so it's now in the Manual mode. Focus cursor becomes controllable and Exposure compensator is still controllable. If user drags Focus cursor to the left side,

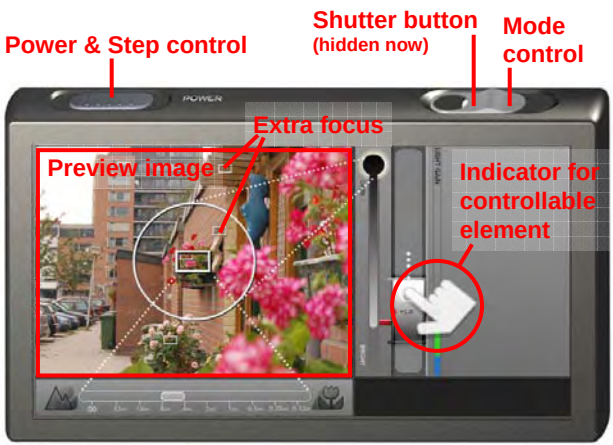


Figure 3.8: A screen shot of the experiential prototype in Step 1 - Automatic mode

the camera focuses on further distance and the preview image also changes its focus on objects at further distance. At the same time, small rectangles (Extra focuses) are positioned on the focused objects.

As user presses the shutter button in the Manual mode, the screen changes to the review mode. However, there's no functionality developed in the mode, thus after a few seconds it goes to the Automatic mode.

Every time when each mode activated, graphic elements look like a hand appear to indicate which on-screen elements are controllable. Several seconds later, the indicators all disappear.

Figure 3.9: A screen shot of the experiential prototype in Step 1 - Manual mode

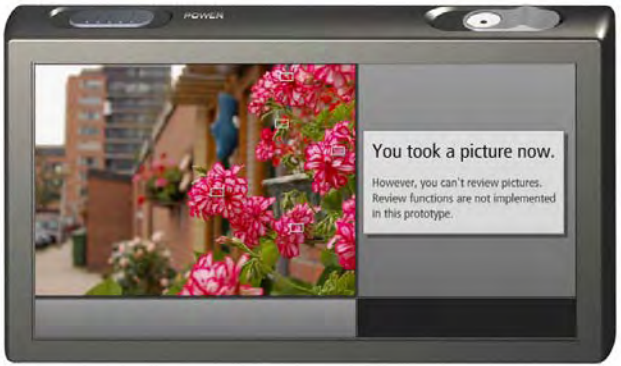


Figure 3.10: A screen shot of the experiential prototype in Step 1 – Review mode

Step 2

Step 2 has every elements in Step 1 and additional features. The additional features are Light gain, Aperture and Shutter speed next to Exposure compensator. Focus cursor in Step 1 evolves into DOF (Depth of Focus) indicator – showing not just focused distance but also the range of it.

Light gain indicates how much amount of light will be exposed on CCD. Height of Light gain is determined by Exposure compensator, which is also dependant on Brightness indicator. By the way, Light gain consists of two bars in green and blue.

The green bar represents the amount of light by aperture value. When aperture gets smaller, as less light comes in, the green bar becomes shorter. However, Light gain compensates the loss of light with longer Shutter speed, in order to maintain brightness of the image. Therefore, tightening Aperture causes longer Shutter speed, but image brightness wouldn't change.

Aperture determines also DOF - wider aperture makes brackets of DOF narrower, consequently getting an image with stronger out-focusing effect.

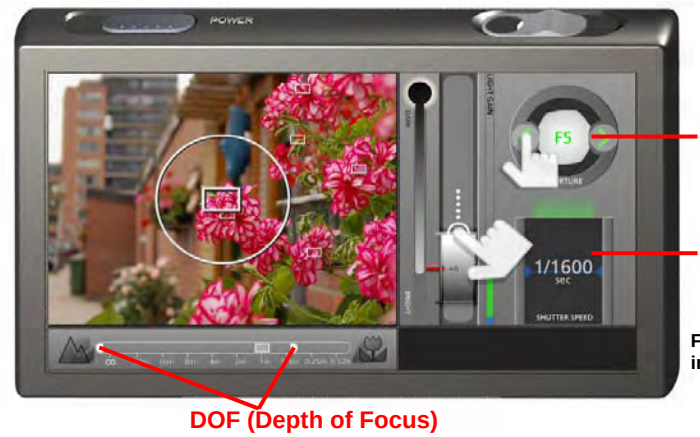


Figure 3.11: A screen shot of the experiential prototype in Step 2 – Automatic mode

As in Step 1, the Manual mode is activated by pushing Mode control to the right side. In the Manual mode, DOF becomes controllable, and Focus / Brightness spot disappears. Other features are same as in the Automatic mode.

Figure 3.12: A screen shot of the experiential prototype in Step 2 – Manual mode

3.3.5 Evaluation of the camera

The camera provides users with opportunities of reasoning the conceptual model behind its functionality. None of the controls are isolated like in conventional digital cameras. Thus using a control in the camera is not just activating the functionality but also a next step of extending his/her understandings about the conceptual model.

The camera provides simple and complete versions of the conceptual model on demand. In the simple version, the user can try to understand basic parts of the conceptual mode. After getting used to it, he/she can go further with the complete version of the model.

4 Experiment

4.1. Introduction

With the experiential prototype which was developed in the previous phase, 6 participants tested the digital camera, in order to investigate *how they interact with the camera* and *what they have understood*. More importantly, *what has been changed after the experiment* was also an aim of the experiment. From this experiment conclusions are drawn regarding changes of participants' photographic knowledge. Finally, design of the camera is evaluated in terms of its contribution on the way of improving user's photographic activity – this is also answering one of the global research questions, *4) What are the effects of the interface on the way of improving user's activity?*

Additionally, because the experiential prototype has been built as an on-screen simulation, it would have biases caused by lack of tactility and practicality. The experimental method is also discussed in this chapter.

4.2. Experimental setup

4.2.1 Goal of the experiment

This explorative experiment was set up to observe interaction between participants and the experiential prototype – the digital camera promoting photographic knowledge with its feedforward-feedback interplay and the scaffolding structure – in terms of user's cognitive activity influenced by the digital camera interface.

4.2.2 Hypotheses

1) The digital camera offers photographic knowledge to users while conventional cameras does not.

2) The photographic knowledge offered by the digital camera changes user's photographic activity to more profound one.

All the participants have been using conventional digital cameras at least for 6 months. Assuming their levels of expertise are by-products of their interactions with own digital cameras, Changes of expertise after the experiment are offered by the digital camera used in the experiment.

4.2.3 Participants

Six volunteers of diverse backgrounds, age (22-34 years old) and gender (2 female, 4 male) participated.

4.2.4 Setup

The experiment was conducted in a quiet room where the tester and participant were sitting at a table. The simulation was ready to run in a notebook computer which was on the table front of participant. Participant were asked to do Talk-aloud, explicitly talking to oneself how he/she feels, what he/she thinks or expects or troubled with. The whole experiment was video-recorded and analyzed afterwards.

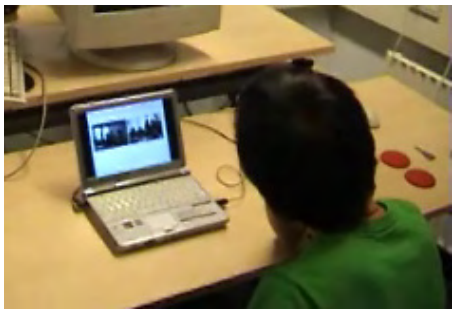


Figure 4.1: Setup for the experiment

4.2.5 Procedure

The experiment consisted of five parts.

1) Opening test

The first part was for evaluating a participant's expertise in photography before using the prototype. In the opening test, seven sets of pictures (see figure 4.2.a,b) were shown and the participant was asked to analyze how the pictures were taken and to imagine how he/she would take pictures in the same situations.

2) Introducing the prototype

The prototype was introduced to the participant as below;

Experimenter: "You'll experience a new interface of digital camera. As it is simplified version for testing, it has limited functionality. I'm interested in what you're thinking during this test. So, please do think-aloud. What you're willing to do, Emotion you feel, Curiosity and Awareness on anything should be expressed by your voice."

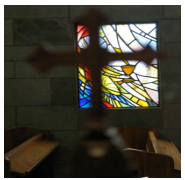
After this introduction, the participant started exploring interface of the prototype. While exploring it, the experimenter explained tactile feelings of physical elements (switches and


#1. This two pictures are taken in a similar situation, but with different techniques. What's the difference? Which one do you prefer / usually take?



#2. These pictures have a similarity. Have you experienced it also? How do you usually deal with it?

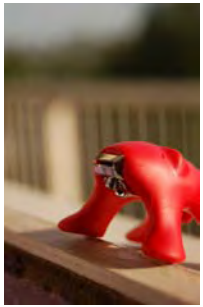
#3. Can you imagine what the photographer wanted to take? If you're in the same situation, how would you take a picture?


#4. In this series of pictures, which one do you like best? Can you imagine how the photographer did it purposefully?

Figure 4.2.a : Sets of pictures used in Opening and Closing test (1/2)


#5. This two pictures are taken in a similar situation, but with different techniques. What's the difference? Which one do you prefer / usually take?




#6. Two pictures below were taken in the same situation with one camera, however, look so different. Why?



#7. This series of pictures were taken in one situation but with different settings. Can you recognize how they've been taken? Which one do you usually use?

Figure 4.2.b : Sets of pictures used in Opening and Closing test (2/2)

buttons), in order to minimize the participant's misunderstandings about the virtual representation of the digital camera. The explanations were like,

Experimenter : "When you pushed the switch (Power control) to the right side, you felt two steps of movement."

Limitations of the prototype were also explained as below;

Experimenter : "By dragging your mouse on the scene image, you can pan the camera. But in this prototype you can move camera only within the limited view."

After few minutes of exploration, when the participant could take any picture, the experiment proceeded to the next step.

3) Taking pictures

With the digital camera, each participant took pictures in total 8 situations. Before turning the camera switch on for each situation, participants were informed briefly about the situation. For the first shot in the situation, no instruction or assignment were given. After the participant took the first shot, the experimenter gave an assignment by speaking for the subject, friends around or sometimes the photographer himself. For example, if a person in the picture had been blurry, the experimenter said 'He complained that his face doesn't look clear and asked you to take one more picture.' Another example of speaking for the photographer can be taking a still-life photograph. For the situation, the experimenter said 'Now imagine that you want to photograph those flowers altogether in one frame.'

Those indirect assignments prevented them from evading difficult situations and taking only passable pictures.

Figure 4.3.a : A situation for taking picture (1/8) : *The experimenter said "They asked you to take a picture of them altogether in one picture."*

Figure 4.3.b : A situation for taking picture (2/8) : *There was no specific assignment in this situation.*

Figure 4.3.d : A situation for taking picture (4/8) : *The experimenter said "Imagine that you want to take a picture of the string hanging at the center of the window.*

Figure 4.3.c : A situation for taking picture (3/8) : *There was no assignment here. But it's difficult to take clear picture in this low-light situation.*

Figure 4.3.e : A situation for taking picture (5/8) : *The experimenter said "Your friend in red shirt asked you to take a picture of him."*

Figure 4.3.f : A situation for taking picture (6/8) : *There was no specific assignment in this situation.*

Figure 4.3.g : A situation for taking picture (7/8) : *The experimenter said "You want to take a picture containing all the flower together."*

Figure 4.3.h : A situation for taking picture (7/8) : *The experimenter said "You want to take a picture of a woman sitting on the bench."*

4) Closing test

With same sets of picture used in the opening test, the participants were asked same questions, but they're allowed to answer by demonstrating with the digital camera they've tested.

5) Interview

In this final step of the experiment, participants were asked about their personal history of photography and general remarks on the prototype.

4.3. Results

Almost 7 hours of video-tape resulted from the experiment was analyzed and some of them were scripted. See table 4.1.

4.3.1 How they interact with the digital camera, What they have understood

Through the observation in part 2 and 3, I could see how participants interact with the digital camera quite unfamiliar to them.

All of them started with switching on the camera quite easily. As they were told about the tactile feedback of the power switch, tried both steps for a while speculating how the two steps are different. After checking both steps, most participants – excepting one of them - stayed at step1 until they faced a unsolvable assignment with step 1 functionalities.

Facing the mysterious on-screen elements for the first time, they all tried to figure out which elements are controllable and what would happen by wandering the interface with the mouse pointer. Afterward they slowly perceived every elements are connected by causal relations. Thus when they can't figure out (or control) one element directly, they tried other adjacent elements.

Without the verbal instruction about how to pan the camera, most participants found it instantly by dragging the preview image once. Also Exposure compensator was one of the easiest elements. Everyone could understand that it controls brightness of the image at once. The meaning of Focus cursor was found quite quickly, but most participants thought the cursor is not

Table 4.1 : Classification of the experiment result

Procedure of the experiment		Type of data	Type of information
1	Opening test	Verbal answer	Participant's existing knowledge about photography
2+3	Exploring interface + Taking pictures	Behavior	How participant interacts with the prototype
		Think-aloud	What participant perceives, expects, tries and understand
4	Closing test	Verbal answer	Participant's changed knowledge about photography
5	Interview	Verbal answer	Personal information

controllable at all (it's correct only in the Automatic mode).

The mode control was a bit hard to be understood. Some participants couldn't perceive the shutter button is below the mode control. Most of them couldn't understand the meaning of the two modes completely. The most common conclusion about the difference between two modes was whether Focus cursor is controllable or not.

The distinction between step1 and 2 seemed very simple and clear, as they understood step 2 is an advanced version of step 1. When they faced Aperture and Shutter speed controls, all of them tried to operate both controls. It took for a while for them to find out the inverse proportional relation between Aperture and Shutter speed.

4.3.2 Comparison between Opening and Closing tests

The two tests are the main indicator of changes in participants' photographic knowledge. As the result of the tests are verbal and behavioral data, in order to get overview of them, I scored the answers for each question in term of three groups of photographic knowledge, defined in chapter. For details, see table 4.2. For each group of knowledge, answers were evaluated into three degrees – '○' for exactly correct answers, '△' for partially correct ones, 'X' were given for incorrect answers or unanswered questions. An example of the evaluation is exemplified in table 4.3. Finally, to sum up all the grades, the grades were changed into numeric points (0 for 'X' ,1 for '△' and 2 for '○'), and participants' points of every question were

Group of knowledge	Evaluation standard
Aesthetic Sense	Could the participant recognize or sense the picture's aesthetic value relevant to the question?
	Examples of Aesthetic value : dark / bright, sharp / blurry, same tone / different tone
Technical knowledge	Could the participant transform the aesthetic value to relevant technical term?
	Examples of Aesthetic value : Exposure, Focus, White balance
Operational skill	Could the participant actually deal with the problem using camera?
	Examples of Aesthetic value : Setting exposure compensation to +2/3, Pressing shutter half-way, Changing white balance to 'Cloudy'

Table 4.2 : Evaluation standard according to three groups of photographic knowledge

Question :
(In the opening test) This two pictures are taken in a similar situation, but with different techniques. What's the difference? Which one do you prefer / usually take?


Answer script	Evaluation
"The left picture is darker than the right one."	[He sensed exactly what's the main difference between two pictures] → **Aesthetic sense : Exactly Correct**
"Here (the Right) people are more on the photo, while light is more on the photo in the left."	[He mentioned that back lighting was emphasized in the left picture, but didn't mention about shutter speed or aperture that are controlling exposure] → **Technical knowledge : Partially Correct**
"I think the right one is nicer. I've experienced the left one several times and wasn't satisfied. However, it depends on mood and situation whether I would try again to have the right one. Normally I just try one more picture with 'In-Door' preset and just leave it out. It's not that big problem for me."	[He doesn't know how to deal with it] → **Operational skill : Incorrect**

According to the evaluation above, his score of question 1 in the opening test is...

#	Description of situation / Related knowledge	A	T	O	Remarks.
1	Taking picture against light / Controlling Exposure	○	△	X	← Opening test
		○	○	○	← Closing test

Table 4.3 : An example of evaluating the test result

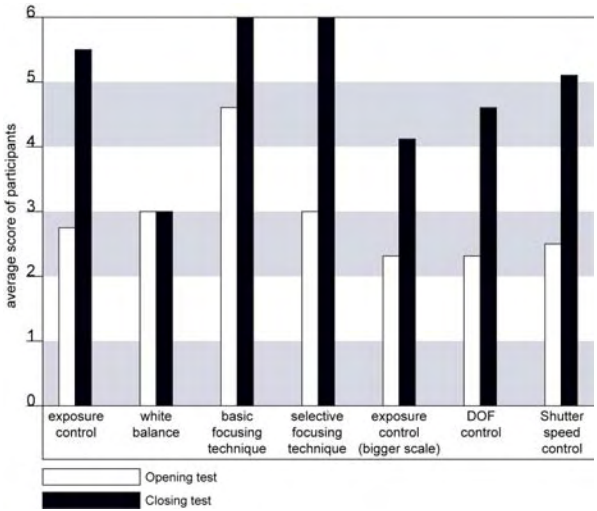


Table 4.4 : Average scores of Opening test vs. Closing test
: Questions are translated into names of relevant controls.

averaged. Table 4.4 illustrates the result – average scores of Opening test vs. Closing test. To see the result of each participant, see Appendix IV.

As shown in the graph (table 4.4), participants answered better for most questions in the closing test than in the opening test. One exception is the question about 'white balance' which wasn't covered in the prototype.

In detail, while 'exposure control', 'basic focusing technique' and 'selective focusing technique' are almost mastered by all the participants, the latter 3 questions – about 'exposure control in bigger detail', 'DOF control' and 'Shutter speed control- seem still difficult for some participants.

An interesting relation between the scaffolding structure and the result score has been found. While the controls completely mastered are exposed in step 1, the other controls seeming more difficult are presented in step 2. Is it due to the scaffolding structure? Unfortunately this question can't be answered with the current results.

The unchanged score of the question about 'white balance' proves that the improvements were caused by the prototype. This is an approval for the first hypothesis - *The digital camera offers photographic knowledge to users while conventional cam eras does not.*

In terms of three groups of knowledge, as shown in table 4.5, Operational skill has been improved most, while Aesthetic sense is almost unchanged. Technical knowledge is somewhere between them. The graphs also shows participants' Aesthetic senses were already very mature – in other words, they could see the difference between pictures – while Technical

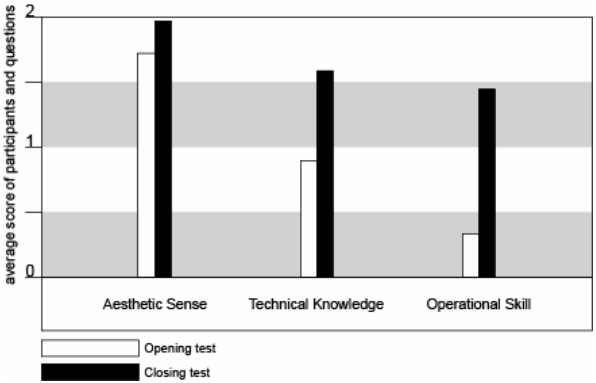


Table 4.5 : Average scores of participants and questions within three groups of knowledge

knowledge and Operational skill have enough place to be improved.

After interacting with the prototype, gaps between three groups of knowledge had been narrowed and I can say that they're more closely connected than before. This is an approval for the second hypotheses - *The photographic knowledge offered by the digital camera changes user's photographic activity to more profound one*

4.4. Discussion

Beside the research question, the exploratory experiment offers insights on the experiment itself and participants' remarks on the prototype. Below I discuss my thought about those topics.

4.4.1 On the experiment:

Bias caused by manipulated motivation for learning

Generally users would take hundreds of pictures with own digital cameras for long-periods, while the experiential prototype was used for taking dozens of pictures within 30 minutes. For that reason, participants were asked to take pictures with some tough requests which they had never done before. A participant said that he had never put much efforts to understand his own digital camera before.

In fact, I assumed that a participant would have very strong motivations for taking better pictures from time to time. Thus the conclusion can be drawn that the digital camera is able to promote user's profound activity, but only on condition of strong motivation.

Bias caused by the prototype's low fidelity

As the experiential prototype isn't a real digital camera, it has some limitations in simulating photographic moments.

First, lacks of tactile feedfowards / feedbacks can be pointed out, because the digital camera's physical properties are virtually represented on LCD monitor. Although this limitation evoked some minor confusions, participants could adapt to on-screen elements quickly.

The second is lacks of freedom in the context. As observed in the photographic excursion, amateur photographers usually take pictures while moving around and changing angle of view freely. However, with the prototype they couldn't move at all, moreover, they can change the angle of view in limited degree. This limitation certainly forced them to stick on other controls of the digital camera to some extent.

As the third limitation, the digital camera has some flaws in technical performance. For example, as it doesn't have image data for various DOF (depth of field) values, effects of DOF changes were explained by the experimenter. Also when participants changed focus, the preview image has changed discontinuously.

4.4.2 Remarks in general

Though not planned as a research question, I could hear the participants' remarks on the digital camera during the experiment. A very common remark was complaints of the digital camera's difficulty. Most of them said that it's hard to understand meanings of every interface elements and they've never tried that hard before.

Nevertheless, they approved of its effectiveness in educational aspect. Each moment they solved a puzzle, figuring out the meaning of the element, I could see their joys of accomplishment. Even one participant said he wants to try again because he didn't understand completely yet.

At the end the experiment, I asked them which element they want to have in their own digital cameras. Most of them picked Exposure compensator and Focus cursor (it also can be DOF), probably because of the controls' directness to photographer's aesthetic needs.

5 Reflections

5.1. Introduction

Looking back the works have been done, now I try to summarize the meaning of this project. It seems not easy at all to say what I've done in a sentence. The starting point was the anecdote about an amateur photographer, however, immediately I've broaden the problem area - electronic products for profound activity. The literature study and the ethnographic studies inspired me of some theoretical and conceptual backgrounds. Through the iterative development, the inspirations were embodied into the experiential prototype. During the experiment, I could observe how people interact with the prototype and the ideas behind it. All these steps are on the same line of research through design approach which Frens (2006) described as : 'gaining knowledge through the process of designing, building and testing highly experiential prototypes'.

Besides, knowledge gained in research through design project has to be taken carefully when being generalized, because of its situation-specificity (Archer, 1995). Thus, in order to answer the final research question - *5) To what extent can the approach be generalized in the problem area? -*, I have to reason the knowledge piece by piece if it would fit to other cases in the problem area.

In this chapter, I summarize what knowledge has been gained throughout the project, with discussing its generalizability at the same time. Ending up the reflection, I suggest opportunities for further researches.

5.2. Gained knowledge and Generalizability

5.2.1 Problem area – electronic product for profound activity

Electronic products are characterized by intrinsic incomprehensibility. However they're diversified into products for shallow / profound activities. By contrasting those two activities, I addressed why some activities should remain profound and defined the design goal (in the problem area) - *Building a smooth pathway from shallow activity (easy for beginners) to profound activity (useful for experts) on user interface of electronic product.*

5.2.2 Interaction model

In chapter 2 Theory, I explored several theoretical issues relevant to the problem area, and proposed an interaction model - illustrating how feedforward-feedback interplays can evoke user's reflective cognition. Reflective cognition then leads the user's learning the conceptual model which is essential for profound activity.

As the model is quite basic and abstract, it can be used in designing any product within the problem area, while many further questions would follow. Briefly saying, the further questions are asking how the interplay should be designed, in order to convey the intended conceptual model which is subordinated to the activity.

5.2.3 Three groups of photographic knowledge

In the ethnographic studies, chapter 3, I focused on digital photography as an example of profound activity, and has classified amateur photographer's knowledge into three groups – Aesthetic sense, Technical knowledge and Operational skill. Although the group names are bound in photography, the meanings are general in the problem area. 'Aesthetic sense' can be replaced by any term depicting user's needs or purpose of the activity. In the same manner, an adequate term in the activity referring knowledge about internal mechanism can substitute 'Technical knowledge'. While 'Operational skill' seems okay to be used generally in the problem area.

Relating the interaction model to the knowledge groups, I concluded that feedforward-feedback interplays are connecting knowledge groups together rather than filling them up. Same to the knowledge groups, the roles of the interplay is also generalizable for any case in the problem area.

5.2.4 Conceptual model and Prototype

I made a conceptual model for developing an experiential prototype, which depicts relationships among each control of the digital camera designed for the research aim. Although both results- the conceptual model and design of the prototype- are very specific to the activity (digital photography), I still believe that they can inspire designers for the other cases in the problem area by demonstrating *how a conceptual model can be expressed with dynamic graphic elements in order to connect each groups of activity knowledge*.

5.2.5 Troublesome, but meaningful interaction

During the experiment I observed how people interact with the prototype. Firstly they tried to find controllable elements on the screen, as the prototype lacks of tactile affordances. Afterward, they've perceived the interplay of feedforward-feedback which is connecting every elements with causal relationships. From the moment, they had abundant moments of reflective cognition and understood the conceptual model to great extent.

All of them said the experiment was very tough, however, the difference between results of opening and closing test shows they've improved their expertise in digital photography a lot.

5.3. Further directions

Now closing the project many opportunities for further researches come into my mind: Should this research be expanded on other profound activities? Should I explore more about people's motivation for learning or creativity (which wasn't covered in this project)? Should further research look at possibilities of tangible interaction?

The first opportunity seems quite feasible and also interesting. Since the network technology has grown up so fast, products are getting connected each other to great extent, thereby activities with connected products have more possibilities to be profound. I expect the number of electronic products for profound activity will grow up from now on.

Considering the second direction, though motivation and creativity are very important in profound activity without question, they're regarded as external factor in this project. In fact, they are still too vague and abstract to be covered in a short project. Nevertheless there's no wonder that it's worthwhile to explore them.

Actually the last direction about tangibility was nearly chosen for this project. As I focused on evolution of profound activity, tangible interaction is a fruitful source of inspiration. A good example can be dancing or sports where actions are evolving from the simplest to very complex one. If using electronic products becomes similar to those activities, having a hard time with electronic products would be much more pleasant and meaningful.

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Appendices.

Appendix I. A set of photographs used in the Interview with amateur photographers

Appendix II. Results of the interview with amateur photographers

Appendix III. Results of the photographic excursion

Appendix IV. Results of the experiment – Opening test versus. Closing test

Appendix I. A set of photographs used in the Interview with amateur photographers






Appendix II. Results of the interview with amateur photographers

Interview #1.

"I always use Auto mode not suitable for low-light situation, so I took picture only in day time…"
> It's a kind of bug in her camera which she could have evaded. But she just accepted it as a limitation of the camera.

"I took a lot of pictures but none of them were successfully representing the feeling I had. There were always discrepancy."
> As a medium, Photography differs from human eyes in many ways. She has to know how to deal with the differences.

"For me, good pictures always remind me a story to tell."
> As a medium, Photography differs from human eyes in many ways. She has to know how to deal with the differences.

"Monuments and structures are usually very big, but the scale is not fully expressed in these pictures. For me this is a frequent unsatisfactory aspect of photography."

"I like this picture, becuase it contains a story. I was peeping into the doorway when she and the woman in the frame are looking each other."

Interview #2.

She uses Film camera, Digital camera and also Polaroid instant camera.

> Sometimes she brings three different cameras all together for a trip. She seems enjoying their differences.

"In cloudy day, I've never satisfied with my digital camera, it always results in a bit dull image. So then, I use my film camera....When I'm using my film camera, it makes me to take pictures more considerately."

> Her experiential knowledge is about the camera's compatibility at a certain situation. The knowledge makes influences on when to take a picture, what to take – but not how.

"I think... better performance of the camera is the source of motivation."

> As a medium, Photography differs from human eyes in many ways. She has to know how to deal with the differences.

"I'm happy when my friends feel happy with my photographs of them."

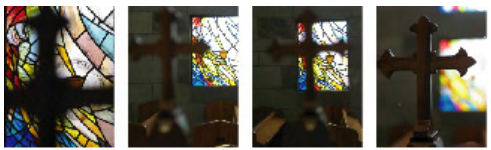
> For amateur photographers, Social value is a common source of motivation.

"But... some people don't have eyes to distinguish better pictures, and therefore they don't want it."

> It's true that an aesthetic sense is important for taking better pictures. But in my opinion, it isn't a pre-requisite but an important by-product of amateur photograph.

"I like this unusual picture most in this album, becuase it has beautiful tones and reminds me pleasure of the moment. I tried several pictures and this is the best."

"Also for this picture I tried many times. If I had a film camera it would have been much easier. On the other side, digital camera doesn't cost any money for this kind of experiment.



"In this series, I played with focus and depth of field. The first one is best for me."

> Good examples of enjoying digital photography : With her knowledge about photography and conveniences of digital technology, she could explore wide possibility of taking pictures.

Interview #3.

"When I started digital photography, I was interested in out-focusing technique and it was the starting moment of my experiments with my camera. In those days, all the good results were lucky shots by the camera's performance…But I slowly became expecting results by myself, for example adjusting exposure setting before taking and checking it. Eventually now I'm considering some aspects for the post-correction in Photoshop while I'm taking photos. "

> His story tells a role of technical experiments in a way of improving one's digital photography. In short, it is actively Expecting, Planning and Reflecting in photographic process.

"What's interesting for me is the difference of image through eyes between lenses… …Also photography can make social values. For example, I go to a party and take nice pictures of people, in order to leave nice memories and to please them. "

> Understanding the difference is challenging, but also can be stimulating. Social values are very important for amateur photography.

"I think post-adjustments with Photoshop can compensate 30% of picture quality, unless focus is blurred or angle is completely wrong…" "Digital photographs are inclined to lose its detail tones near white rather than black. Therefore I take pictures a bit darker than real, and manipulate it brighter in Photoshop."

> As one's techniques in digital photography improve, procedural steps can compensate each other.

An Example of Photo Gift

An Example of Experimental Photography

"If you want to learn photography techniques, you should understand basic optics - exposure, depth of field. But I think you can take nice pictures with Auto Mode also. As I think framing and timing is responsible for 40% of picture quality, you should expect better picture from your camera, don't ignore its possibility. "

> It's true that an aesthetic sense is important for taking better pictures. But in my opinion, it isn't a pre-requisite but an important by-product of amateur photograph.

Interview #4.

She presses the shutter button halfway and check the green/red rectangle on the subject which indicates the situation is all right or not. As the camera doesn't have an option to show more detail settings, now she doesn't care about them.
"Without them, my pictures are all~ OKAY."
> Her process of taking picture is a kind of common activity. But…

"Ah... this picture's blurred.. I didn't check. I couldn't do anything about it. For the final shot I used a flash but I know it won't be good with flash - which makes the picture having no depth. However, It's really hard to hold my camera firmly."
> In some situations, she couldn't take useful pictures because she's not interacting with detail controls of her camera.

"I wanted to take a beautiful picture of these goats, but it's just a FLAT GOATS - which doesn't have depth, front and back elements. In my memory, they're so sweet, but in this picture mud and grass take my eyes."
> Same

"It was sunny day and I was so happy. As I like Rotterdam central station, I took these pictures. But the second picture is too flat and the composition of two buildings are not as good as I expected. It looks too small... And, the sky is not blue. The feeling I felt was not fully shown in these pictures. I had a feeling that the building is an image of Rotterdam, but hmm... not fully expressed."
> She could make an aesthetic critic about a picture, but couldn't analyze and translate into technical solution.

"Here's the tree I like. At the second picture, I tried to catch the feeling of its curved shape, but it wasn't satisfactory. So I tried once again at the third pictures, it was quite okay. This picture has a different point of view from what I usually see with my eyes."
> What she said was contradictory. She tries to catch a specific feeling, but the successful picture is quite different from what she saw with her eyes.

Interview #5.

"Comparing to film cameras, digital camera which doesn't cost any film makes me taking a lot of pictures at every moments without considering when and what to take. In that sense, I feel that my camera is taking picture, instead of me. That's not a good feeling. Sometimes, just looking around and feeling more with my own eyes are a better way for enjoying the moment.
After the trip, we could see a lot of mediocre pictures of the same subject. With digital camera, photography is time consuming activity of which the result won't be striking."
> It's a problematic remark for most digital photographers taking a lot pictures without any expectation.

"Normally I just press the shutter button halfway and directly press it completely. I checked whether the focus and the exposure is alright with my old film camera, But it's normally okay with my digital camera. "
"I don't know how to get sharp pictures inside buildings. Photos would be blurry because my hands are always moving. So, in dark environments like a club, I don't bring my camera, because I know that I won't be able to take nice pictures."
> It's contradictory; show knows problematic factors but doesn't consider them while taking pictures.

"I've used Scene modes but it didn't make any big difference, so now I'm just using Auto mode."
> Most operational techniques are useless unless they know when it works well and how to use it. Moreover, if once they feel it's useless, they don't try again and again.

"I know one technique. If I set a focus on a darker side, the picture gets brighter. I came to know it from experiences so I don't know its principle. I just have a brief idea that the camera calculate brightness based on the center of the frame. I know it also can be changed but not how to control it with this camera."
> She has some useful experiential knowledge directly connecting an operation and aesthetic quality. However, without technical knowledge, she can't expand it for another knowledge.

"After I took the first picture, they said the faces are too dark. So I set a focus on their bodies for the next shot, then the background became too bright."

Appendix III. Results of the photographic excursion

Participant 1.

History : - Beginner's Digital camera [age 18]
- Intermediate film camera [age 20]
- Intermediate Digital Camera [age 22]
- Polaroid instant Camera [age 22]

Camera : - Canon Powershot G5,
- Nikon FM2 (amateur film camera)

NIKON FM2

Purpose of photography :

-To chat with friends about interesting pictures

General usage of camera :

(In general case) Program mode with flash off

HALF-PRESSED SHUTTER REFRAMING is always used.

Only when pictures are clearly bad, she changes the setting.

When she can expect really nice picture, she uses film camera.

CANON POWERSHOT G2

General Image Manipulation :

Cropping, Curves

Comments :

"Because of this cloudy weather, pictures in LCD look also dim. I think that makes me not enjoying photography in cloudy days. That's why I like film camera more than digital camera. Through film cameras' viewfinder, I can see the world as it is – They are sharper and brighter than on LCD." (She wants vivid color and strong contrasts)


"I like taking interesting objects. I should've turned on the Close-up option. I couldn't notice it's blurred because I didn't check it. I thought it would've been okay."


Often, variations of pictures for a certain subject are varied by the photographer's location and orientations of camera – landscape or portrait.





Her friend gave own camera to her for taking these funny self-directed shots.

When everybody has own cameras, photo-taking is also an interesting subject for photography.

Typical variations of camera orientation – landscape or portrait.

"When it's cloudy, my digital camera cannot collect the beauty of colors. So I brought my film camera which can make more vivid images."

Variation of composition


"At the old toilet, the first shot was blurred because it was too dark. So I selected higher ISO sensitivity and took it again."

First she takes pictures with her usual setting. If the picture wasn't satisfying, she changes the setting.



Often the subject of photography is moving from the overall situation to small details.

"As the kids are the subject, I took this picture from the lower position than usual."

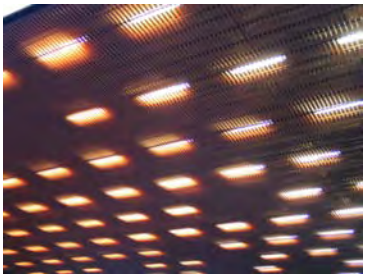



"Combination of those kids and my friend was the subject of this pictures."


"As the sky was cropped (in the right picture), the building got brighter which is not good. I like colors in the left picture and I think it's still over-exposed."

"When I started using this camera, I had used the bracketing option. Though it is useful to know when the auto-exposure can be wrong, it ends up with a lack of storage because of too many shots."






"For these pictures (below), I focused on compositions not on tones."

Participant 2.

History :

from 2002, still using same digital camera.

Cameras :

Canon Powershot S30,

Polaroid instant camera

Purpose of photography :

-To show atmosphere of the Netherlands to her boyfriend

-To chat about interesting pictures

-She mainly takes pictures of objects not people.

General usage of camera :

Av mode in most case. Manual mode rarely. When the light is too low, she set higher ISO.

Aperture is usually full-opened. HALF-PRESSED SHUTTER REFRAMING is always used.

First, she just take a picture in the normal setting (Av, Aperture wide open, minimum ISO, auto-exposure on the main subject) and only if it's too bad, she looks for adequate changes."

Image Manipulation:

Cropping, Curves, to make white as white

Comments :

"Actually I'm not ready for taking pictures, it always takes too long time to take my camera out and turning it on. (after losing her chance for taking picture of a pretty dog moving) "

"While I'd like to be taken by others in group tourism pictures (referring a picture of her with companions at the front of a beautiful spot), I don't take that kind of pictures with my camera. "

"Long time ago, I took lots of pictures in many different ways. But nowadays, collecting the atmosphere of the moment is just enough for me. I'm not trying to make professional pictures."

"When a photographer loves the subject, pictures are much better!"


CANON POWERSHOT S30

"I waited on a cue for a long time to see the exhibition. This picture was taken when I finally got to the entrance. Maybe I'll tell the story to my boyfriend with this picture."

"I like this kind of alleys."

"Do you also think that these landscape images are dimmer than you saw?"

"No… I think it was actually same. I like the tone of my camera. It's clearer and more vivid than my friends' camera."

"People in old ages also drew stars on the ceiling… So cute… But the feeling was not captured very well because of the composition. So sad. Anyway I moved to the next place."

She knew what she wanted to take and her first trial failed. It's meaningful that she didn't try more.

"I wanted to capture the image of light coming into dark room."

"This is a unique and beautiful scene of the Netherlands."

"The funniest picture with patats."

"The flowers are beautiful. Also the focus of the picture is clear."

Participant 3.

History :

4yrs ago, she started photography with a simple beginner's digital camera.

2yrs ago, she bought her current digital camera.

Camera :

LUMIX DMC FZ5 - Not so small, but very light. (She focused on portability also on good performance)

Unique simple mode with Heart symbol. When the power is on, the display briefly introduce the current mode. Close-up function is not an option for general use, but a separated mode.

Purpose of photography :

-collecting nice memories during trip and interesting objects/events from daily life.

-she mainly takes pictures of objects not person's.

"It's not easy to take pretty pictures of people, unless they're already in a good pose."

-posting it on her blog.

General usage of camera :

CLOSE-UP mode, SIMPLE mode, rarely MANUAL mode.

HALF-PRESSED SHUTTER REFRAMING is always used.

She also used camera's LCD for sharing her previous memory

General Image Manipulation

Cropping, Curves, to make white as white

Comments :

"Carrying and holding this big digital camera is really a troublesome job. I really want a small camera… but with a good quality. Hmm.. Like a revolver gun in a holster"

"I like portrait shots than landscape one without any reason."

"I know lots of techniques… but laziness or lack of time makes me not to use those techniques."

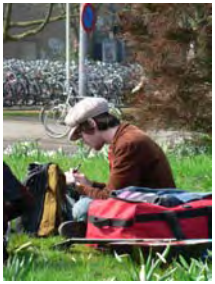
"Landscape pictures are always not as good as I see. That's why I like close-up pictures."

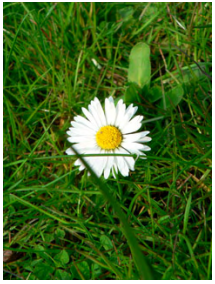
"Landscape pictures are too dim… White are not white as I saw. I don't know why."

"I hate spending time for tedious setting at the most. I prefer using Photoshop."

LUMIX DMC FZ5

Reviewing pictures in her camera



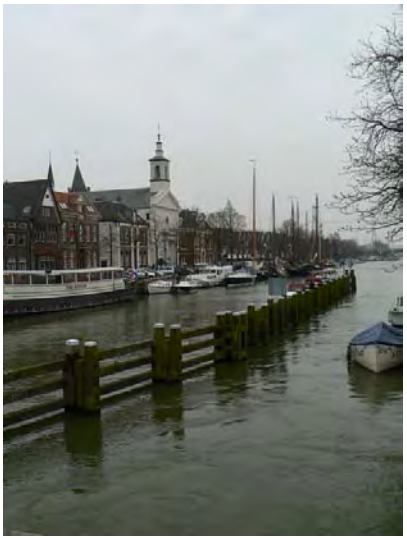


She usually takes pictures varied in orientation – Landscape and Portrait. But she usually prefer portraits.

"I like portrait shots than landscape one without any reason."

"I wanted to focus on the reeds, blurring out the boats in the background. I know how to do it, but everybody's walking on our ways and I didn't have enough time to control my camera to do that."

Sometimes photographers know how to take a nice picture but they don't have enough time or motivation for the operation of their camera.



"I like to take pictures of objects much more than landscape pictures which never be taken as good as they look. They're dim. I think they're actually sharper and more vivid than these pictures."

"The subject – which is a window hole for defending the castle – was interesting… a feeling of looking outside through the hole. But these pictures are not so interesting as I expected."

Participant. 4

History :

15yrs ago, he started photography with an amateur film camera - EOS 1000 .

11yrs ago, he bought a better film camera – EOS 5.

compact digital camera – SONY Cybershot DSC-U10.

Intermediate digital camera – LEICA Digilux1

compact digital camera – LUMIX DMC LX1

Camera :

LUMIX DMC LX1. His camera has an unstable auto-exposure problem.

Purpose of photography :

Capturing a certain moment by pressing the shutter

Taking a series of pictures with a theme (roof, pavement with own feet, sign post)

General usage of camera :

Bracketing with -+2/3 stop (because of the unstable A-E problem)

HALF-PRESSED SHUTTER REFRAMING is always used

Various film proportions (3:4 , 9:16)

General Image Manipulation :

only Auto levels, Auto contrast. No Cropping

Comments :

"Though I'm not fully satisfied with my photos, I don't want to spend extra time or efforts on taking professional pictures."

"If I wanted to get good-looking pictures, I would buy DSLR camera. But portability and quick snapshots are more important to me. That's why I'm still using my compact digital camera."

"What I like about my camera is … the quick access to various film proportions. With this camera, I frequently change the film proportion between 3:4 and 9:16."

LUMIX DMC LX1

0 - 2/3 + 2/3

"My digital camera cannot find a correct exposure for the scene. Therefore I have to use the bracketing option every time."

"Without any reason, I like to crop out people's bodies in my frame. Similarly, in general the main subject of the scene isn't dominant in my photography…

… Oh… these pictures are disclosing all my distorted personality… haha…"

"Looking outside through the castle window… it seemed interesting but the result isn't as good."

"As an architecture student, I'm interested in those construction process."

An extensive social interaction was provoked by Polaroid photography.

"…You need this bag for the base?"

"…Please cut me out of the frame…"

"…Polaroid photography shouldn't take too much consideration~…"

"…This camera has LCD screen…"

"…There is a Polaroid camera whose films can be smudged with a finger…"

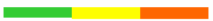
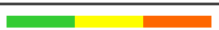
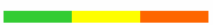
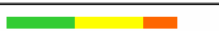
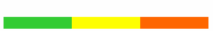
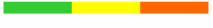
"…Haha… Look at his hair… so shaggy~"

"…Polaroid camera only needs bright sunlight…"

Appendix IV. Results of the experiment – Opening test versus. Closing test

A : Aesthetic sense
T : Technical knowledge
O : Operational skill

Participant 1

#	Description of situation / Related knowledge	A	T	O	Remarks.	
1	Taking picture against light / Controlling Exposure	○	△	X	← Opening test	
		○	○	○	← Closing test	
2	Blue pictures / White balance	○	○	○		
		○	○	○		
3	Blurred main subject / Basic Focusing technique	○	○	△		
		○	○	○		
4	Picture set with focus variation / Selective Focusing technique	○	○	X		
		○	○	○		
5	Taking picture against strong light / Controlling exposure (in bigger scale)	○	△	X		
		○	△	△		
6	(Slightly/Strongly) Out-Focused images / Controlling Focal depth	○	○	X		
		○	○	○		
7	Taking picture in low light situation / Controlling shutter speed	○	△	X		
		○	○	○		

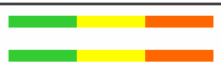
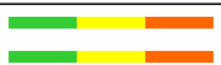
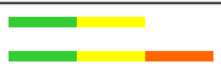
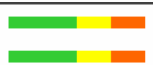
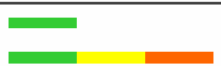
A : Aesthetic sense
T : Technical knowledge
O : Operational skill

Participant 2

#	Description of situation / Related knowledge	A	T	O	Remarks,	
1	Taking picture against light / Controlling Exposure	△ ○	△ △	X X	← Opening test ← Closing test	
2	Blue pictures / White balance	X X	X X	X X		
3	Blurred main subject / Basic Focusing technique	○ ○	X ○	X ○		
4	Picture set with focus variation / Selective Focusing technique	△ ○	X ○	X ○		
5	Taking picture against strong light / Controlling exposure (in bigger scale)	X ○	X △	X △		
6	(Slightly/Strongly) Out-Focused images / Controlling Focal depth	X △	X △	X ○		
7	Taking picture in low light situation / Controlling shutter speed	△ ○	X ○	X △		

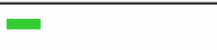
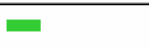
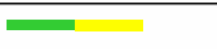
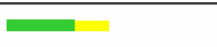
A : Aesthetic sense
T : Technical knowledge
O : Operational skill

Participant 3

#	Description of situation / Related knowledge	A	T	O	Remarks.	
1	Taking picture against light / Controlling Exposure	○ ○	△ ○	△ ○	← Opening test ← Closing test	
2	Blue pictures / White balance	○ ○	○ ○	○ ○		
3	Blurred main subject / Basic Focusing technique	○ ○	○ ○	○ ○		
4	Picture set with focus variation / Selective Focusing technique	○ ○	○ ○	○ ○		
5	Taking picture against strong light / Controlling exposure (in bigger scale)	○ ○	△ △	△ △		
6	(Slightly/Strongly) Out-Focused images / Controlling Focal depth	○ ○	X ○	X ○		
7	Taking picture in low light situation / Controlling shutter speed	○ ○	△ ○	△ ○		

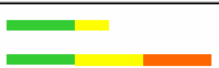
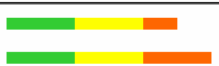
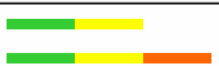
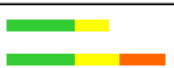
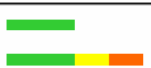
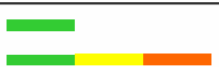
A : Aesthetic sense
T : Technical knowledge
O : Operational skill

Participant 4

#	Description of situation / Related knowledge	A	T	O	Remarks.	
1	Taking picture against light / Controlling Exposure	○ ○	△ ○	X ○	← Opening test ← Closing test	
2	Blue pictures / White balance	○ ○	X X	X X		
3	Blurred main subject / Basic Focusing technique	○ ○	○ ○	△ ○		
4	Picture set with focus variation / Selective Focusing technique	△ ○	X ○	X ○		
5	Taking picture against strong light / Controlling exposure (in bigger scale)	△ ○	X △	X △		
6	(Slightly/Strongly) Out-Focused images / Controlling Focal depth	○ ○	○ ○	X ○		
7	Taking picture in low light situation / Controlling shutter speed	○ ○	△ ○	X ○		

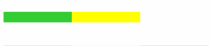
A : Aesthetic sense
T : Technical knowledge
O : Operational skill

Participant 5

#	Description of situation / Related knowledge	A	T	O	Remarks.	
1	Taking picture against light / Controlling Exposure	○ ○	△ ○	X ○	← Opening test ← Closing test	
2	Blue pictures / White balance	○ ○	X X	X X		
3	Blurred main subject / Basic Focusing technique	○ ○	○ ○	△ ○		
4	Picture set with focus variation / Selective Focusing technique	○ ○	○ ○	X ○		
5	Taking picture against strong light / Controlling exposure (in bigger scale)	○ ○	△ △	X △		
6	(Slightly/Strongly) Out-Focused images / Controlling Focal depth	○ ○	X △	X △		
7	Taking picture in low light situation / Controlling shutter speed	○ ○	X ○	X ○		

A : Aesthetic sense
T : Technical knowledge
O : Operational skill

Participant 6

#	Description of situation / Related knowledge	A	T	O	Remarks.	
1	Taking picture against light / Controlling Exposure	○ ○	X ○	X ○	← Opening test ← Closing test	
2	Blue pictures / White balance	○ ○	X X	X X		
3	Blurred main subject / Basic Focusing technique	○ ○	○ ○	△ ○		
4	Picture set with focus variation / Selective Focusing technique	○ ○	○ ○	X ○		
5	Taking picture against strong light / Controlling exposure (in bigger scale)	○ ○	△ △	X △		
6	(Slightly/Strongly) Out-Focused images / Controlling Focal depth	○ ○	X ○	X X		
7	Taking picture in low light situation / Controlling shutter speed	○ ○	X X	X X		

This thesis describes Master research as a graduation project (2006)
in Design for Interaction at the faculty of Industrial Design Engineering,
Delft University of Technology, the Netherlands.
Chair of supervisory team: Prof. Dr. Pieter Jan Stappers
Mentor of supervisory team: Dr. Stella Boess
Duration: 1 January ~ 26 Sep 2006

For more information, contact to the author via email : reflect9@gmail.com