Technologies for Everyday Life Reflection: Illustrating a Design Space

Ine Mols [1,2]
i.mols@tue.nl
[1]Eindhoven University of Technology
Dept. of Industrial Design
P.O. Box 513, 5600 RM
Eindhoven, the Netherlands

Elise van den Hoven [2,1,3,4]
elise.vandenhoven@uts.edu.au
[2]University of Technology Sydney
Faculty of Design Architecture and Building
Ultimo NSW 2007, Australia

Berry Eggen [1,2]
j.h.eggen@tue.nl
[3]ARC Centre of Excellence in Cognition and its Disorders

[4]DJAD, University of Dundee
Dundee, UK

ABSTRACT
Reflection gives insight, supports action and can improve wellbeing. People might want to reflect more often for these benefits, but find it difficult to do so in everyday life. Research in HCI has shown the potential of systems to support reflection in different contexts. In this paper we present a design space for supporting *everyday life reflection*. We produced a workbook with a selection of conceptual design proposals, which show how systems can take different roles in the process of reflection: triggering, supporting and capturing. We describe a design space with two dimensions by combining these roles with strategies found in literature. We contribute to the extensive body of work on reflection by outlining how design for everyday life reflection requires a focus on more holistic reflection, design with openness and integration in everyday life.

Author Keywords
Design Research, Reflection, Conceptual Design

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

INTRODUCTION
We go about our everyday life and many activities, often without thinking about it. This normality and self-evidence is also what makes our everyday life so everyday. However, from time to time, we might think about our lives, our actions, thoughts, habits and choices. Through reflection we gain insight and learn lessons. Reflection has been extensively discussed in the context of learning and professional development [18, 21, 25]. Within healthcare and design, reflection often gives insight [3]. Rather than 'only' insight, the foreseen benefit in much work on personal informatics is *action*. The line of reasoning suggests that showing users data about themselves will lead them to do something, presumably something different from and better than what they are already doing [15]. Rather than reflection for these specific goals, we focus on what we call *everyday life reflection*, referring to all deliberate and critical thought processes concerning our day to day activities. This includes themes such as work, health, relationships, leisure time and personality. We see value in engaging in everyday life reflection regularly, as a way to gain self insight and improve overall wellbeing. A moment of reflection can bring the mind at ease, provide a feeling of confidence or help solve problems.

However, engaging in reflection is far from straight forward. It is a complex process with many contextual factors involved. Design to support reflection is therefor a challenging, but worthwhile ambition. In this paper we build upon the conceptual grounding by Baumer [3] and the landscape described by Fleck & Fitzpatrick [8], aiming to make their dimensions more specific and applied to the domain of *everyday life* reflection. As part of a research through design process, we have developed a set of thirty ideas to support reflection. Through the multiplicity of ideas, a design space emerges [9]. We provide a set of *alternatives;* alternative design concepts that support reflection in different ways. We use the process of designing these alternatives and the resulting set as a way to reflect on design for reflection in general. In this paper we describe this design space by presenting concepts and the *roles* we see support systems can take in the process of reflection. Before doing so, we will discuss related work to defining reflection and discuss common strategies to support reflection. In line with Sengers [22] we end the paper by reflecting on our own work and process as well, providing suggestions for designing for everyday life reflection focusing on holistic reflection, openness in design and the integration in everyday life.

DEFINING REFLECTION
Despite its widespread use, the term reflection often lacks a thorough definition in HCI work [3,7]. Here, we discuss some definitions of reflection to better ground our work and explain our perspective. Baumer [3] explicitly provides a very inclusive definition of reflection as *"reviewing a series*

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of previous experiences, […] putting them together in such a way as to come to a better understanding or to gain some sort of insight." [p. 94] This broad definition gives a good starting point for the types of processes we focus on but provides little insight in how this reviewing leads to insights. This process is described in more detail in the model presented in [24] in which reflection is reviewed within a psychological view on autobiographical memory. Here, reflection is seen as "*remembering plus further analysis*" [p. 150]. This analysis is divided in multiple layers, first of all split in either evaluation or explanation of the remembered experience. On a third layer, the model describes the underlying processes that can lead to provides more grip on the processes involved in reflection: abstraction, comparison, categorization etc. We combine these process aspects with the type of insight we strive from, inspired by Mezirows theory [18]. Specifically we build upon his definition of *critical self-reflection* as "reassessing our own orientation to perceiving, knowing, believing, feeling and acting."[p 13]. From a memory and HCI perspective we are interested in the role external triggers play in this process. Together, these bring us to our definition of everyday life reflection as: "*Remembering and analyzing past, present and future experiences in order to reassess our perceptions, beliefs, feelings and actions regarding our everyday life."* This definition is the basis for our concept development, however, first we will discuss related work on reflection support with a more inclusive perspective on reflection.

REFLECTION SUPPORT

Reflection takes time and for many people it does not come naturally, they usually need a reason to reflect or at least encouragement to do so [8]. An overview of different ways of supporting reflection can be given by domain [3] or sorted by level of reflection [8]. In stead, we provide an overview based on the adopted *strategy* to support reflection. We were interested in strategies currently adopted, both within and outside of HCI. Based on a broad review of methods and tools in different fields including personal informatics, HCI, therapy and education we describe three main *strategies* to stimulate reflection. We emphasize that this is not a complete overview of all possible strategies, but a summary of the most recurring strategies in our literature review.

Dialogue driven reflection

Reflection often occurs in dialogue, this is most evident in therapists dialogues or teacher-students dialogues. We refer here specifically to verbalized dialogue, either in writing or spoken, rather than the more abstract notion of reflective conversation with 'material' as Schön introduced [21]. In dialogue driven reflection, questions or explicit prompts are used to encourage reflection. Within therapy or education such a dialogue is often done between "uneven partners" in which one takes the lead but people also reflect with friends or peers in group sessions [20]. In relation to HCI, dialogue driven reflection can be *about* a design [2] or mediated *by* a system. A combination of both is seen in the design of Loversbox [26]. In this design people can create messages for their partner (dialogue mediate by the system), talk with an artist to create these message (reflection about the system) and can reflect together triggered by the system.

Examples in which the system takes the leading role by asking questions can be seen in Echo [11] and the use of experience tags in photos with Storytellr [14] in which the system poses questions such as "how do you feel?" "What theme do you associate with this event?". Such questions create a dialogue between system and user, however, dialogue often holds after an initial question, an intelligent system would engage further in dialogue driven reflection by posing follow-up questions.

Information driven reflection

Presenting data can be a trigger for reflection, at least it is a premises often seen in personal informatics and quantified self movement. Data can be very helpful when reflection is aimed at uncovering patterns or for reflection aimed at behavior change. Different characteristics of information are used to stimulate reflection: invisibility, comparison, ambiguity or multiple views. Information driven reflection is effective when revealing information that is otherwise *invisible* or cannot be directly observed, such as steps taken during the day [e.g. 7]. Data Souvernirs [1] for instance, reveals 'hidden' digital data in the physical world to stimulate reflection. Sometimes data is presented in specific way, for instance to allow for *comparison* (cf. comparing neighborhood energy consumption in RevealIt, [28]) For these types of applications clarity of information is important. The opposite effect is seen in other cases, where the *ambiguity* of the data triggers reflection (cf. History tablecloth [10]). Finally, information driven reflection can be supported by providing multiple views on the data to enable exploration, for instance of personal memory artifacts in MemoryLane [12] or the design process in Freed [17]. These examples show the diversity of potential applications of information driven reflection and the important role the systems and interactions play in this. Many of these are more goal-oriented types of reflection, with the use of Sensecam images [16] explored reflection with a more open approach. When reviewing Sensecam images, participants for instance reflected on their social interactions or on incremental change over a long period of time.

Expression driven reflection

Reflection can be an internal process, but can also be based on externalizing thoughts and feelings. In diaries and in reflective writing the reflection occurs while striving to *express* oneself. Expression driven reflection is traditionally seen in personal diary writing, which Travers [27] even considers as the purest form of self-reflection, in therapeutic writing [29] or in more creative areas such as art therapy [6]. Orland-Barak [20] have explored expression driven reflection as part of a portfolio in teacher education,

however portfolios were dominantly descriptive and emotional rather than showing critical reflection. Additional guidance on what to reflect upon could help. Such a more guided approach to expression driven reflection was explored by Andre et al. [2]. They designed expressive avatars, in which busyness, stress, health and engagement can be expressed. These choices require reflections and as such stimulates to reflect on our well-being.

DESIGN PROCESS

By looking at this variety of examples of supporting reflection we see a gap in concepts that support *everyday life* reflection. In many existing concepts we see that a very specific subject is reflected upon, for instance energy usage [28], movement or professional development [20]. In our definition of everyday life reflection we focus on a broad set of past, present and future experiences, leading to a more holistic type of reflection. Based on Staudinger's [24] view of life reflection we see everyday life reflection as a process of looking for connections across domains with the possibility to reflect on deeper beliefs or presuppositions [18]. This is a highly individual and personal process and to allow for this requires a certain openness in our designs.

Inspired by the work by Gaver [9] we set out to develop a set of *alternatives* to describe this design space. These concepts were developed iteratively. First ideas were individually generated by the first author and coded for their potential values. After that a brainstorm with three colleagues aimed at maximizing and minimalizing these concepts, looking for the boundaries of their potential. Because these concepts were highly influence by the researchers original ideas and direction, a third brainstorm was a set up to more broadly generate ideas. A definition or goal of reflection was deliberately not discussed with the four researchers involved in this brainstorm. Together, these workshops resulted in a set of 48 ideas. The results were analyzed in a group discussion by comparing them to the strategies found in literature, consequently also refining these strategies (resulting in the three presented before). Through these brainstorms and discussions a set of 25 concepts was developed. In this paper we present a selection of these to illustrate what insights we gained from this process. Specifically, reflection on our concepts gave insight in the *roles* we see systems can take. We hope that both the emerging design space and the individual concepts can inspire to look at design for reflection differently.

DESIGN SPACE

Reflection is often done with someone else, who takes a supporting role (a tutor, psychologist or peer). In the personal context of everyday life reflection, systems can take this role of a "reflection partner" in various ways. Systems can *trigger* reflection, *support* the process of reflection or enable *capturing* reflections. These roles can not be completely separated and a systems can adopt different roles at different moments in the process.

Datazen
A small zen-inspired garden used as an ambient display. Through vibration in the bottom, patterns in the sand are created that are based on measurements of activity, stress and wellbeing (based on wearables). You can choose to edit, disturb or change the display which is done through the relaxing strength of a zen garden.

Balance
A wooden balance that functions as a subtle display of the balance in your life as it stores your thoughts on its positive and negative sides. You can tap to record on either side, adding weight to that side. A physical trigger, an abstract representation of state and an achieve of previous thoughts.

MirrorMirror
The bathroom is a typical place to start and end a day. In a moment that we look at ourselves, MirrorMirror stimulates to look at our selves in a more reflective way. To take a moment to consider the day, the week or ourselves. Contours of hands trigger to stand still a moment. When hands are placed on plaque, the mirror slowly starts to draw an outline around you. Takes 3 minutes to make outline, take time to reflect during this time.

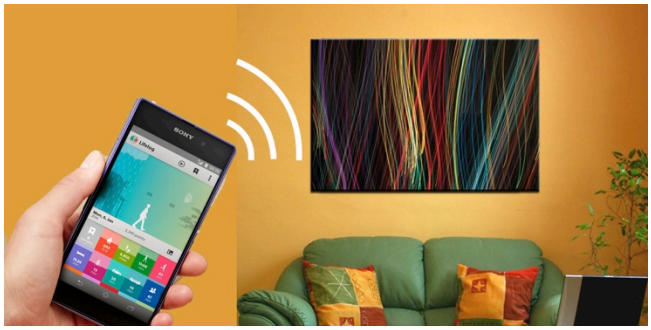
Figure 1. Concepts with (a) content triggers, (b) direction triggers and (c) opportunity triggers

Triggering Role

Similar to how a comment or question from a friend gets you thinking, an interactive system can take a *triggering role.* Based on our concepts, we identity different types of triggers that a system can provide. *Content triggers* provide direction for what to reflection on, for instance by presenting data or media. To stimulate everyday life reflection we focus on presenting data from a broad range. However, peoples self-image can be conflicting with the image presented through data. The concept DataZen (Figure 1a) therefor allows people to adjust the pattern presented based on their personal view on how the data should represent their present or preferred future. The notion of breakdown [4] or the ambiguous visualization of data (e.g. [8]) can also be seen as content triggers. Being more open than content triggers, *direction triggers* give a suggestion for the type of reflection without limiting the content of the reflection. The Balance concept (Figure 1b) for instance suggest to reflect on two sides of a situation (e.g. positive and negative) without prescribing what this situation should be. The most openness is seen in systems that provide *opportunity trigger*. Concepts such as MirrorMirror (Figure 1c) indicate that there is (or could be) time and space for reflection, without giving any further direction.

Supporting Role

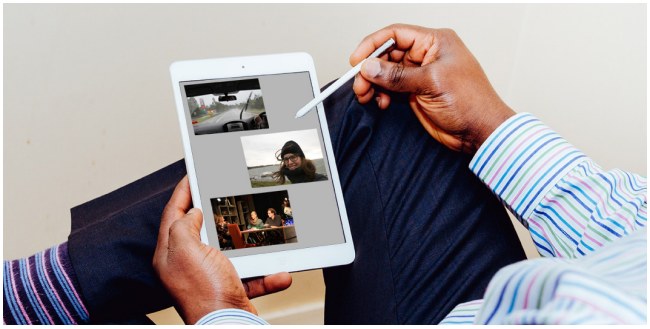
Technologies for everyday life reflection can be designed to provide *support* in the process of reflection. This can be done both after a person has been triggered by the system, or if reflection is initiated by the person. Support can for instance be given by exploring layers in system-collected data, step by step (lifeTree concept Figure 2) or exploring user generated media in a more playful way (oddOneOut, Figure 3a). Rather than free exploration MixedEmotions (Figure 3b) stimulate reflection by supporting a process of guided choices. The process of MixedEmotions can be seen as an example of *embodied questions*.



Life Tree

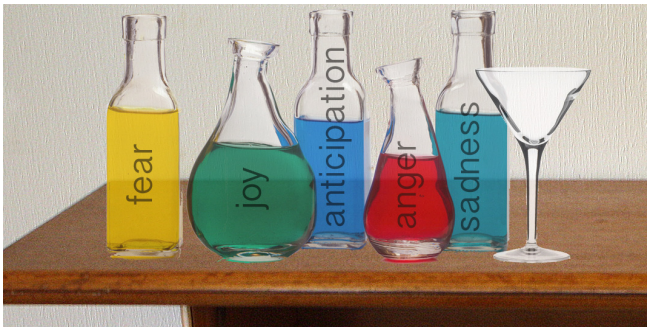
A beautiful piece of art on the wall in your house, with a hidden meaning. As the patterns represent patterns in your live visualizing activity, social engagement, stress and health. The interactive art piece allows to explore aspects of the data to find peaks, patterns or surprises. At the same time it functions as a more peripheral trigger for reflection without invading your privacy.

Figure 2. Concept that support exploration of system generated data



OddOneOut

A short moment on the couch playing a nice little game you're your pictures. The game of "odd one out" stimulates looking at hidden similarities and differences between random photos from your personal past. With all associations, a growing web of related photos is created which can be reviewed and explored.



MixedEmotions

Every day is a mix of experiences and emotions, but at night we need to let them go. MixedEmotions creates a night time ritual that is relaxing and supports a good night sleep. Mixing a herbal mix every night, stimulates reflection each bottle representing an emotion. How did your day taste? Which bottle empties the quickest?

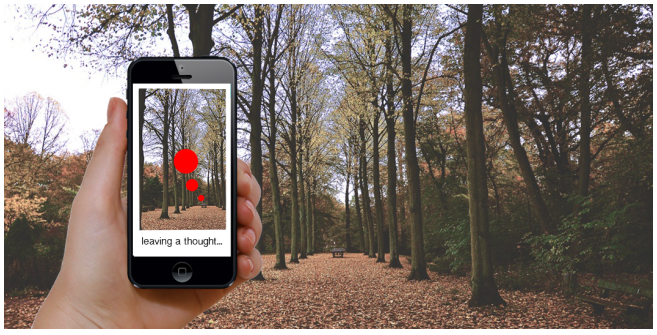
PeelAway

Getting to the core of a problem can help us gain insight. On each segment of PeelAway an aspect or thought can be written and peeled off, stimulating to write down underalying aspects and explore underlying thoughts or assumptions, resulting in more critical reflection.

Figure 3. Systems that take a supporting role

FragileWorries
A set of abstract ceramic figures in which can be written upon. Write worries down and break them to let go or show how vulnerable worries are. Shards can be saved as a reminder of past struggles or disposed of to truly get rid of the past.

PastScape
Hear a soundscape from the past, connected to the location you are in. Scroll through the decades, was there a city here? Do you here cars or horses? Provides opportunity to get away from the present, get to a different place, see things in a different perspective



Trail
Reflection often requires getting away from everyday life activites, for instance with a small stroll. With Trail you can save thoughts or reflection on specific locations, creating your own garden of thought to which you can return for future deliberation. Creating not only an environment, but personal messages to your future self.

Figure 4: System that support capturing reflection (a, c) or provide an environment for reflection (b, c)

Very few of our concepts use explicit, verbalized questions, in contrast to some of the dialogue driven reflection systems discussed before [11, 14]. In stead, we see opportunity for concepts that use more subtle prompt and embodied questions. This can be seen in the concept *'PeelAway'* (Figure 3c) which uses the embodiment of layers to dig deeper into underlying aspects of a thought or problem. PeelAway supports reflection not only through an embodied question but also through *physical action.* The action of peeling away, or in the Fragile Worries (Figure 4a) concept breaking figures is supportive of the cognitive an ungraspable process of reflection.

Finally, the most subtle form of support, is seen in providing environment support. After being initiated by the user, PastScape (Figure 4b) creates en environment for reflection by creating a metaphorical distance from current activities to allow for reflection. After being initiated by the user, PastScape creates en environment for reflection by creating a metaphorical distance from current activities to allow for reflection. ungraspable process of reflection.

Capturing Role

Rather than triggering to start reflection, systems can support closing the process of reflection by supporting externalization. Capturing our reflections through externalization has two important benefits. First of all, externalizing thoughts can help to bring peace of mind, a focus in FragileWorries (Figure 4a). Secondly, capturing reflections can serve as content triggers in the future. The Trail Concept (Figure 4c), allows people to leave reflective messages in specific locations. Similar to Echoes [11] a collection of responses to earlier reflections could emerge.

Dimensions of a Design Space

In the introduction we presented multiple strategies: expression, information or dialogue driven reflection. From our open brainstorm multiple roles emerged. Some roles map easily to certain strategies, see Figure 6: information often takes a triggering role, systems supporting capturing can rely on expression driven reflection and dialogue is a strong form of support. However, all other combinations spark useful insight as well, in Figure 5 we have mapped our concepts to this design space, this shows how several concepts change roles during the process: the visual aspects of LifeTree provide content triggers, but the opportunity to explore the layers of data behind this provide support. The Balance concept shifts through all roles: the physical form and current status trigger to reflect, the interactivity that changes the scale support reflecting from multiple perspectives and finally the recorded messages are captured and can be later reviewed. Mapping our concepts to these dimensions, also lead to defining a fourth dimension: *environment driven* reflection (see Figure 6). This strategy focuses on creating contextual elements that are beneficial for reflection, which could draw on notions of restorative environments [1].

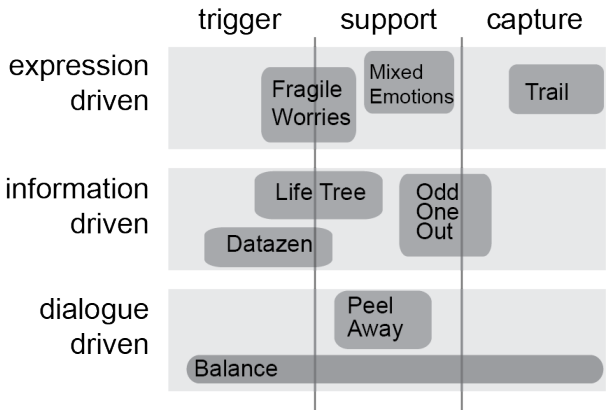


Figure 5: Mapping conceptual reflection systems in emerging design space

Defining the space across these two dimensions has contributed to our design process and understanding in several ways. First, we can use the space to analyze current strategies and can use this to compare concepts in a structured way. Secondly, it allows to redesign reflection systems: for example a regular diary is based on capturing expression driven reflection (top right corner), but can be redesigned to include dialogue driven triggers, see for example the physical diary by Mols & Markopoulos [19], the redesign is indicated in Figure 6. Thirdly, the two dimensions illustrate opportunities within the design space. The visual for instance triggered the question how we might design for expression driven triggering. This lead to the idea of a "ThoughtsCanvas": an empty canvas that triggers to express, but fades after a night sleep, leaving no trace. In this way, the entry can not be revisited and the trigger remains open, which positions the concept in the top left corner.

DISCUSSION

We have presented this design space as inspiration and guide, giving direction to potential future work on supporting reflection with a more holistic and open approach. We have build upon work by [3, 4, 8, 25] to provide specific dimensions aiming to give more direct suggestions for design. Although these dimensions might be useful for any type of reflection, we specifically aim at everyday life reflection focusing on insight (rather than behavior change or skill-development). Based on our work we discuss three other elements that are import specifically for this type of reflection: holistic reflection, openness in design and embedding in everyday life.

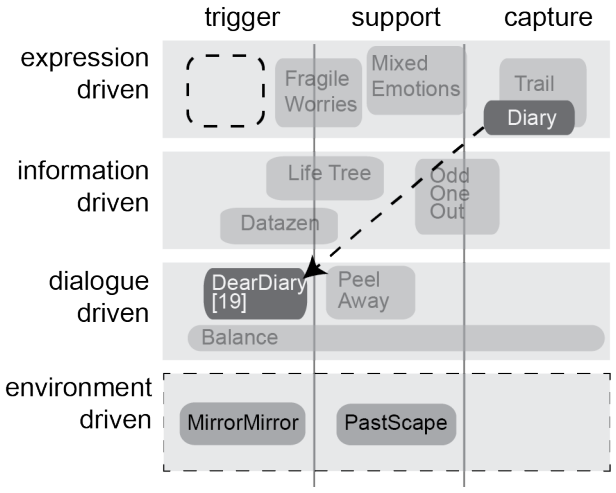


Figure 6: Design spaced used to define opportunities for design, redesign and new strategies

Holistic reflection

Most of our concepts do not focus on a specific behavior or domain. We see the biggest benefit for everyday life reflection if different experiences, life aspects or domains can be combined. Systems that use content-triggers often provide focus, but therefor also limit our reflections. The OddOneOut concept uses a very diverse set of input, by reflecting on the similarities and differences between media, more abstract insights can be generated.

Openness in Design

Because of the personal and holistic nature of everyday life reflections, designing for it should be approached with a high degree of openness. In our concept openness is seen for instance in the use of direction or opportunity triggers. We focus on designs that allow to be appropriated and that allow for interpretation, making meaning through use [23]. The game of OddOneOut for instance, has no specific goal and its meaning or benefits can only be interpreted through use. The Balance concept is an example that can be easily appropriated to use for different types of life balances (positive & negative, work & leisure).

Integrating Reflection in Everyday life

Reflection requires time, structure and encouragement [8]. For systems to contribute to these elements, they need to be integrated in everyday life. For everyday life reflection to truly improve reflection it needs to become a habit adopted over a long period of time. Integrating systems for reflection in everyday life in a meaningful way is very challenging. Echo [11] for example is a concept strong in all roles of triggering, supporting and capturing, however it is less integrated in everyday life. Echo triggers at random moments, which leads to surprising entries, but can also be very disturbing. There are many moments during the day when the resources for reflection (time, mental effort, isolation) are not available. Allowing for better integration into everyday life can be done in several ways.

Everyday Life Rituals

Reflection requires time and attention and the skill to reflect develops over time. Concepts such as Balance recognize this and aim to create a new ritual for daily reflection, with a fixed location and timing, for instance when coming home. Other concepts integrate reflection in current everyday life rituals (MirrorMirror), reducing the effort required to adopt the new habit. In OddOneOut, we we adopt a more flexible approach and aim to "lighten" the process of reflection by game elements.

Layers

Enabling embedding reflection in everyday life is also achieved by designing for the different 'layers' of reflection. As described by Fleck, R., & Fitzpatrick [8] and Kember et al. [13] reflection on the deepest layers are not always necessary. In stead, concepts can support multiple laywers, by allowing for both reflective descriptions or comparison (first layers) as well as more critical or transformative reflection on a deeper layer [8]. Such designs will allow for short moments of interaction as well as for more time-consuming and deliberate reflection (for critical or transformative reflection). E.g. adding a note to the Balance concept is a small moment of insight, but reviewing past balances and their potential pattern over time is on a deeper layer. Although interactive systems might be most suitable to stimulate more descriptive levels of reflection [8], we can combine these layers with different interaction styles to support more critical reflection.

Social Roles

In our design space we focused on systems that take the role of a reflective partner, allowing users to engage with a dialogue with themselves [5]. However we could also imagine systems that mediate or support reflection with a partner. Although not explicitly designed for this purpose, several concept can stimulate reflective conversation through their presence in the home environment. The abstract representation in concepts such as LifeTree or Balance allow for responses from close ones when meaning is shared. E.g. partners living together can start a conversation if they see much has been added to the Balance. One could even use such a system together rather than individually. At the same time, Balance takes the privacy of reflection into account, for people not informed about the meaning, it remains an abstract sculpture. Including intimate others in the process of reflection can support integrating reflection in everyday life.

Reflecting on the process

Concepts were generated iteratively, with different people involved in different phases. Iterations have shaped the design space, as have our discussions and analysis. From a critical perspective we should recognize that most of the involved researchers have been … in a reflection-driven educational system and therefor all have quite a reflective attitude. Therefore, similar to [3] our work is based on the premises that people benefit from reflection and focused on people willing to engage in reflection. We do not focus on a persuasive approach but rather focus on empower people with the desire to reflect more often but who can use support.

Although we have strived to make both dimensions of strategies and roles as specific as possible, they still on a conceptual level. The see the design space *"not as a problem space, but as a complex situation in which we pose interventions* [4], which can help us to better understand reflection itself. The value of these concepts can only become clear in use, through a process of meaning making, the concepts have been designed to allow for multiple meanings. [23]. However this also means that, in use, they might be used more pragmatically or functional rather than reflective. Only long term evaluations in real can uncover the reflective potential of these concepts.

CONCLUSION

Reflection can have many benefits and is a topic of great interest within HCI and personal informatics. However, most current work is focused on supporting reflection on specific aspects. Instead, in this paper we have illustrated a direction focusing on everyday life reflection with more holistic and open approach. We presented a design space illustrated with several concepts. By combining the supporting roles a system can take and different strategies to drive reflection we hope to inspire future work everyday life reflection.

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