Reflecting on Reflection: Framing a Design Landscape

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ABSTRACT
Designing for reflection is becoming of increasing interest to HCI researchers, especially as digital technologies move to supporting broader professional and quality of life issues. However, the term 'reflection' is being used and designed for in diverse ways and often with little reference to vast amount of literature on the topic outside of HCI. Here we synthesize this literature into a framework, consisting of aspects such as purposes of reflection, conditions for reflection and levels of reflection (where the levels capture the behaviours and activities associated with reflection). We then show how technologies can support these different aspects and conclude with open questions that can guide a more systematic approach to how we understand and design for support of reflection.

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Reflection, reflective practice, sensecam, learning from experience, design guidelines.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Reflection, in the sense defined by the Compact Oxford English Dictionary (Accessed 2010) as "serious thought or consideration", is a term used frequently in everyday language. Notions of reflection and reflective practice have been of interest to the HCI and related communities for some time, if not as a central notion at least as a component of the topic of interest. For example, work on technology support for learning (e.g. Price et al., 2003; Yukawa, 2003) and play (e.g. Rogers & Muller, 2006) have drawn on notions of reflection to motivate design choices, often referencing Boud's work on 'reflection in learning' where reflection is described as "a generic term for those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to new understandings and appreciations" (p19, Boud et al., 1985). Support for reflective practitioners, particularly informed by Donald Schön's work (1983), has also been a focus of attention, both for supporting professional practitioners such as teachers (e.g. Jay & Johnson, 2002; Lee, 2005), as well as talking about design itself as a reflective practice (e.g. Brereton & McGarry, 2000) and reflection in the design process e.g., (Smith et al., 2004). Schön describes reflection as a type of 'thinking about' which enables a kind of problem solving involving the construction of an understanding and reframing of the situation to allow professionals to apply and develop the knowledge and skills of their profession. Sengers et al. (2005) further talk about the emergence of 'reflective design' that "combines analysis of the ways in which technologies reflect and perpetuate unconscious cultural assumptions, with design, building, and evaluation of new computing devices that reflect alternative possibilities". More recently, health has become a focus for talking about self-reflection, promoting healthy behaviour change (e.g. Anderson et al., 2007) as well as promoting greater awareness and learning to self-manage chronic conditions such as diabetes (Mamykina et al., 2008).

With the expanding focus of digital technologies from usability and meeting requirements to the importance of experience and enjoyability etc., the interest in reflection and technologies to support reflection has expanded beyond these more traditional domains to a range of new areas, with reflection as a topic in its own right. This is evidenced by a workshop on technology support for reflecting on experience at CHI2009 (Sas & Dix, 2009). The aim of the workshop was "to explore the movement from designing for experience as interaction with technology, towards designing for reflection on felt-life experience captured by technology". One such area is reflecting on everyday experience making use of new sensor-based and mobile technologies, (e.g. Harper et al., 2007; Lindström et al., 2006). Others talk about reflection more in terms of provoking new ways of thinking and seeing. For example, some interactive experiences are often said to 'provoke' or 'invite' reflection e.g., (Gaver et al., 2003; Hindmarsh et al., 2002; Sengers et al., 2002).

However, despite this growing interest, designing for reflection is still in its infancy, as noted by Sas and Dix (2009). What is even more in its infancy is some shared understanding of what it is we are designing for when we talk about reflection. From the diverse work around reflection, it is clear that people are working with very different definitions, and using the same term across very different domains for very different outcomes. Given this observation some e.g., Draper (1999) would argue that reflection is not worthy of prominence in its own right (talking particularly of learning): "I find there are many senses of "reflection", and most who use it don't seem to have reflected on this. If new practice is worth developing there should be a clear theoretical position behind it; and if there is a clear theoretical position then at the very least clear definitions and discussions of how this is and is not consistent with other usages should be available. […]

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This unclarity means among other things that perhaps we all do it anyway […]. After all, "reflection" just means "thinking", and I'm sure we all agree that thinking is helpful to learning."

Others, for example Moon, do not agree, suggesting that there is such a thing as reflection, which is "a form of mental processing with a purpose and/or an anticipated outcome that is applied to relatively complicated or unstructured ideas for which there is not an obvious solution" (Moon, 1999, p98). Much confusion, she argues, lies in the fact that authors are describing different *purposes* for reflection. She suggests therefore that apparent differences in the notion of reflection across domains are down to how it is used, applied or guided.

Therefore, while it could be possible to debate about which definitions of reflection are better or to attempt to synthesize one definition, neither will be particularly useful to help inform design decisions about when, where and how technology could support reflection. We suggest instead that, for the purposes of design, it will be far more important to synthesize the diverse understandings of reflection from the literature in order to pull out aspects of it for consideration in design.

We proceed then by returning to the literature on reflection in order to identify a number of *aspects* thought to be associated with good reflection. We go on then to use these aspects to illustrate how technology is, and may be used in the future, to support reflection, and finish by drawing out some key concerns for those intending to design for reflection. The key contribution of this paper then is to present a theoretically-grounded framework of reflection as a resource for design.

ASPECTS OF REFLECTION

In this section we outline a number of aspects of reflection identified in the literature, organized as purposes for reflection, some of the necessary conditions for reflection, and types of behaviours and activities thought to be associated with good reflection which we have organized into 'levels of reflection'.

Purpose of reflection

As stated previously, reflection can serve many different purposes, which in turn influences how that reflection happens. Drawing on Moon (1999, p98), examples of different purposes include: learning and the material for further reflection; action or other representation of learning; reflection on the process of learning; critical review; the building of theory; self-development; decisions or resolutions of uncertainty; empowerment or emancipation; and other outcomes that are unexpected – images or ideas that might be solutions.

Conditions for Reflection

There are also various points raised in the literature about creating the *right environment* or *conditions* for reflection that are worth mentioning here. Firstly, reflection takes *time*: therefore creating or allowing time for reflection is essential (Moon, 1999). Secondly, reflection is discussed by many authors as a *developmental* process, and people can learn to be more reflective over time and with support (Gustafson & Bennett, 2002; Moon, 1999; Ward & McCotter, 2004). This may not be so much the case for some purposes of reflection (e.g. the quiet contemplation of your old holiday snaps for pleasure). However, where the purpose of reflection is more formal, for example in reflective practice setting such as teacher training, structured support or guidance of reflection is of value. Finally, as reflection is time consuming and not necessarily something that comes naturally to people in all situations, they usually need a reason to reflect or at least *encouragement* to do so (Gustafson & Bennett, 2002; Moon, 1999).

Levels of reflection

From the definitions presented earlier we can see how different definitions of reflection often incorporate some of the types of behaviours and activities associated with reflection for a purpose. In some domains, in particular those related with learning from experience, the behaviours and activities thought to be associated with reflection are often organized into different 'levels' of reflection, and presented as a means to identify reflection occurring, or to evaluate that reflection. Whilst there is much discussion about the validity of attempting to evaluate reflection (e.g., see Sumison & Fleet, 1996) the idea of such levels of reflection is useful to us here as they indicate what it is that is considered as reflection or reflective thought and behaviours in the literature.

However there is disagreement between authors about the levels, what falls into each 'level', and even at what level reflection begins to occur. In general though, higher levels are considered most reflective, and any example of reflection would be judged as being at the highest level for which there is evidence. It is also suggested that the lower levels are prerequisites for higher levels (Hatton & Smith, 1995). For the purposes of design, as we shall see, these lower levels are particularly relevant as they point to technology support opportunities from which higher levels of reflection may follow.

We present below five different 'levels of reflection', R0 (the lowest) to R4 (the highest), synthesized via critical engagement with these diverse literatures on reflection, in particular literature about teachers' (and professionals') reflective practice and learning from experience; and further refined through the iterative application of early versions in case studies of technology-supported reflective practice of teachers (see Fleck 2008 (unpublished thesis) for a detailed discussion). While developed with respect to teachers' reflective practice, we suggest that the general principles of the levels are broadly applicable to other domains.

R0 Description: Revisiting

Description or statement about events without further elaboration or explanation. Not reflective.

The R0 level is description. Many authors (e.g. Hatton & Smith, 1995; Manouchehri, 2002) describe a category of discussion or writing that is a purely descriptive revisiting of events, with no indication of the types of thought described in categories below. In fact, Hatton and Smith

reported that up to 60-70% of their students' writing fitted this category, and although Davis considered anything their students wrote in reflective exercises as reflective (as this was the students' intent), much of it was considered unproductive (Davis, 2006).

R1 Reflective Description: Revisiting with Explanation

Description including justification or reasons for action or interpretation, but in a reportive or descriptive way. No alternate explanations explored, limited analysis and no change of perspective.

The R1 level occurs when explanations accompany descriptions. Unlike R0, discussion or writing is considered by many authors to actually be reflective only if explanations or justifications are provided for actions in the revisiting of events (Hatton & Smith, 1995; Manouchehri, 2002). This first level of reflection is variously distinguished from higher levels: for example, Hatton and Smith (1995) include only explanations given in a reportive or descriptive way; Ward and McCotter (2004) state analysis is limited and there is no change of perspective; and Lee (2005) states that no alternate explanations are explored. Others might still not consider this definition evidence of reflection (e.g. Davis, 2006; Kember et al., 1999).

R2 Dialogic Reflection: Exploring Relationships

A different level of thinking about. Looking for relationships between pieces of experience or knowledge, evidence of cycles of interpreting and questioning, consideration of different explanations, hypothesis and other points of view.

Level R2 goes beyond reflective description with or without explanation, to probe relationships emergent in the descriptions. It is often referred to as dialogic reflection, as it primarily involves seeing things from a different perspective (e.g., Jay & Johnson, 2002; Manouchehri, 2002) and considering alternatives (e.g., Davis, 2006; Ward & McCotter, 2004), aspects of an ideal conversation with another. Searching for relationships between ideas and experiences in order to generalize from them and reach a different level of understanding is also associated with this level of reflection (e.g. Davis, 2006; Lee, 2005).

R3 Transformative Reflection: Fundamental Change

Revisiting an event or knowledge with intent to re-organise and/or do something differently. Asking of fundamental questions and challenging personal assumptions leading to a change in practice or understanding.

Whilst dialogic reflection is described as looking for relationships, considering alternatives and seeing things from a different perspective, level R3 is about transformative reflection and includes the idea that the reflector's original point of view is somehow altered or transformed to take into account the new perspectives s/he has just explored. It is suggested that in order to achieve this perspective transformation: "it is necessary to recognise that many of our actions are governed by a set of beliefs and values which have been almost unconsciously assimilated from the particular environment" (p23, Kember et al., 1999). Such a transformation is thought to follow from and build on earlier levels of reflection: other points of view or alternate explanations are considered so reflectors' own initial assumptions are challenged and their ideas restructured or reframed. This might ultimately lead to a change in practice, or if the purpose of reflection is not linked to action, at least a fundamental change in understanding.

R4 Critical Reflection: Wider Implications

Where social and ethical issues are taken into consideration. Generally considering the (much wider) picture.

This final level of reflection, R4, is termed here critical reflection (a term sometimes also used to describe the type of reflection classified as transformative above, (e.g. see p251, Ward & McCotter, 2004)). It involves taking into consideration aspects beyond the immediate context, for example moral and ethical issues, and wider socio-historical and politico-cultural contexts (Alder in Hatton & Smith, 1995; Kember et al., 1999; Ward & McCotter, 2004). Reaching this level of reflection is reportedly very rare (e.g., Kember et al., 1999; Moon, 1999; Ward & McCotter, 2004).

TECHNIQUES FOR SUPPORTING REFLECTION

In presenting these aspects of reflection – organized as purpose, conditions and levels – we are moving away from defining reflection per se to highlight the issues to consider when understanding the enabling role that technology can play in facilitating reflection.

There are many ways to create the time for and guide and encourage the different levels (types of behaviours and actions) of reflection we have highlighted above, most of which can be tailored to the specific purpose of reflection required. Moon (1999) provides a comprehensive account of many of these, including: writing techniques; use of reflective questions to explicitly guide or structure reflection; techniques for making use of dialog and discussion; various non-verbal techniques; encouraging review or revisiting of materials or events; using evaluation (for example assessments) to encourage reflection; using ill-structured material; and any other method for creating situations which require aspects of reflective thought such as those which challenge initial thinking and assumptions, or require the making of judgments or the integration of new and old learning. Missing from her account though is a discussion of the vast potential offered by technology to support reflection not only via these techniques, but in new ways too. Using the aspects defined above, we go on here to provide a preliminary outline of ways technology can and has been designed for reflection. Following this we present a case study which illustrates these techniques in practice for a particular purpose.

Supporting R0: Technology for Revisiting

R0 is the level at which technology can provide significant support in providing informational resources for reflection. Although, as discussed earlier, simply stating what is known, looking at information or data, or looking back on events or experiences is not considered reflective on its own - it is often the foundation on which

later reflection is based. Any representation of existing information or knowledge can form the basis for reflection on that information – be that oral, written or pictorial. The non-technology technique of writing or journaling for reflection on experience is valuable in that it provides a record of experiences (and usually reflections on these) over time that can be looked back over, shared or compared. Supporting memory by providing a record of knowledge, events, experiences and thinking over time is the most obvious way that technology can be used to support reflection.

Technology can be used as the tool through which knowledge and experience is recorded in a direct extension to the non-technology techniques above. For example, electronic portfolios (e.g. Loh et al., 1997) can replace pen and paper journals, allowing the addition of all sorts of electronic data to be 'journaled' and subsequently reflected on. Life-logging (e.g. Allen, 2008) could be considered an extreme case of journaling, where all available data from everyday life is recorded and kept to support future reflection. The attraction of keeping electronic records, in terms of reflection, is that they can be more easily searched, reorganised and shared (and they take up less space). Other non-technology techniques for representing knowledge, including spatial-mapping techniques like mind-mapping can similarly benefit from digitisation.

In addition, a record of events is often the automatic outcome of using technology. For example, Seale and Cann (2000) promoted the use of online discussion forums to support students' reflection precisely because they provide a record of discussions that can be returned to in the future in a way face-to-face discussions cannot. Similarly, technology can be used to create visual/audio records of experience with the use of video, photography, audio recording technologies. New forms of information can also be captured through the use of sensor devices, wearables and additional context information – giving access to information that otherwise might not be perceptible or available to normal memory.

Supporting R1: Technology to Prompt Explanation

Most authors agree that providing justifications or explanations for knowledge, events or one's actions is an indication of at least low-level reflective thinking. Often when looking over a representation of one's information or knowledge, or looking back at actions or events either from memory or from a record of those events, people spontaneously think or reflect in this way. However, a standard non-technology technique for encouraging more of this in situations where useful reflection for the intended purpose is not so natural, is the *asking of reflective questions*. These are designed to get reflectors to think specifically about issues that are considered important for the particular purpose of their reflection. Essay questions, for example, are broad reflective questions to direct thought to the subject matter being covered. More specific questions might be to direct attention on the process of what you are doing in order to learn from it (meta-cognition, self-reflection or reflective practice.)

Therefore, one way to prompt reflectors to think about what they are doing and provide justifications or explanations for knowledge, actions or events, is to ask them to do this. Such *reflective questions can be incorporated in various ways to technology to promote this aspect of reflection*. For example, in interactive learning environments, such as Gama (2001), questions can be used to prompt students as they work through the system to answer various reflective questions about their understanding of the problem, their related previous knowledge and strategies used to answer the problem.

Similarly, annotation technologies could promote reflection through the use of reflective questioning. For example Storytellr (Landry in Sas & Dix, 2009) encourages people to tag their digital photographs with experience based tags through prompting with reflective questions such as "What emotions (positive or negative) do looking at this image evoke?" for the purpose of storytelling with the images later. Experience sampling techniques can also be used to encourage reflection, sending prompt questions to mobile devices, triggered for example by context-sensitive settings (Intille et al., 2003). Interactive concept mapping tools such as Belvedere (Paolucci et al., 1995) or Convince me (Schank & Ranney, 1995) also prompt for justifications and explanations. They do this by providing skeleton structures that encourage participants to organise their knowledge into nodes of information and think about whether these nodes support each other or contradict them, and the technology (acting almost like another person) prompts them to do this if they have not adequately achieved this.

The presence of another person is also beneficial in encouraging the giving of justifications or explanations, as it makes sense to explain things to other people, especially if they do not share the same knowledge, understanding or experience as you. Any kind of record of events or representation of knowledge can form the basis for discussion between two people – allowing each to ask the other for explanations or justifications where needed. For example, in the eScience project, children worked in groups to collect data about their environment, then talked to real expert scientists via web-chat who were able to ask them questions of their data (Smith et al., 2005).

Supporting R2: Technology to See More

We have described how this level of reflection involves a questioning of events or knowledge, and a consideration of different explanations, hypotheses or points of view. This type of thinking can follow from lower levels of reflection prompted by the techniques already discussed. It can also be *encouraged through the use of techniques that can enable the 'seeing of things from multiple perspectives'* a theme which crops up throughout the literature on reflection again and again (Ackerman, 1996, Boud et al., 1985; Schön, 1983).

Technology has the potential to do this in many ways. For example it can be used to *produce a record of events which can be looked at again*; there may be things that

have been forgotten and a recording can provide time to focus attention on different aspects of the experience on each return, especially if some guidance as to what to focus on is provided (Hutchinson & Bryson, 1997; Sherin & van Es, 2002), possibly through the use of reflective questioning.

Also technology has the potential to *allow you to see more than you could possibly see alone*, for example sensor technologies can record, detect and represent data or aspects of experiences not otherwise available to human perception. This aspect of seeing from a different perspective can mean that more information is available to the reflector in order to make sense of events, or consider the implications of their actions. This extra perspective may be available at the time of the experience: Back et al. (in Sas & Dix, 2009) describe anecdotally how wearing a heart beat monitor allowed them to reflect on the immediate impact of the exercise they were conducting (running on a treadmill) on their body. Similarly, in the Ambient Wood project (Rogers et al., 2004) an Ambient Horn was developed to 'make the invisible visible' by playing abstract sounds to represent hidden processes, such as photosynthesis, in the wood to encourage children to consider various different hypotheses for what was going on in the wood.

Looking back on any visual/audio recording of events is always literally going to let you see the experience from a different view-point to your own which can allow you to see and hear things out of your own scope of awareness at the time (Fleck and Fitzpatrick, 2009). A record of collected sensor data can also allow you to look back on experience with the added extra perspective of more information available to understand events. In addition, such records allow you to relate different views to each other, or to look for patterns that are only observable by stepping back to get an overview. For example, in the eScience project students collected wind direction, strength and carbon monoxide readings at various locations and put these things together in a replay tool to try to explain what was going on. Also, Clippingdale et al. (in Sas & Dix, 2009) suggested the use of sensors to analyse the patterns of movement of patients suffering from depression in order to infer information about their mood states over the day. By encouraging these patients to log other information throughout the day, it was hoped that the patents would be able to relate their mood to other events in their lives, and therapists would be able to monitor their response to treatment. The purpose of reflection in the above examples is quite clear cut: the extra perspective offered by the technology directly lends itself to the kind of abstractions or links that can lead to the reflection/understandings intended by the designers. A similar technique was successfully used to help diabetic patients monitor and relate their blood sugar levels to their diet and exercise in order for them to begin to develop an understanding of this relationship (Mamykina et al., 2008).

However, *similar techniques can be used to encourage much more contemplative reflection*, where designers have a less clear purpose in mind. For example the Home Health Monitor (Gaver et al., 2003) is embedded with various sensors such as light, temperature and door sensors to monitor people's activities around the home, the results of which are then used to give feedback in the form of a horoscope to allow people 'to reflect on the emotional state of their home'. Similarly, the ambient display 'dangling string' (Weiser & Seely Brown, 1997) consists of a string dangling from the corner of hallway that whirs and moves in response to network activity, without any explicit design intention as to what being peripherally aware of this information will lead to.

An alternate perspective can also be provided by another person: therefore any record of knowledge or experience can be used to share that knowledge and experience with others. As well as encouraging the generation of explanations and justifications as described earlier, their interpretation of data or events may differ from yours, providing a different perspective. Therefore the techniques discussed earlier which support conversation can also provide reflectors with this alternative perspective. In addition, sharing and comparing different experiences can provide more material for generating alternate explanations or hypotheses or to the questioning of knowledge/events, the other aspects of level 2 reflection.

Technology can also provide the means by which reflectors reorganize their knowledge to see it from multiple perspectives. For example, digital concept-mapping software can both allow reflectors to move nodes around to reorganize their ideas, and to automatically re-represent ideas in a different format: for example commercial mind mapping software usually includes features where a spatial diagram of mixed nodes can, at the click of a button, be transformed to say a bulleted list. Visualisation tools can allow the exploration of data in different formats.

In terms of supporting the aspects of reflection at this level, seeing from another perspective in the ways described above can lead to consideration of different points of view. The extra information about events provided by these other perspectives can lead to the consideration of multiple hypotheses to explain what's going on. Finally, where this extra information does not fit with existing hypotheses or explanations of events, multiple perspectives can prompt a questioning of knowledge and even a questioning of events.

Simulation environments (and other similar interactive learning environments) can also support reflection through allowing the *quick and relatively cost free exploration* of these environments, allowing participants to experience different possible outcomes, and reflect/hypothesize as to what might be causing them. In addition, they can improve on real life environments by making more information visible (as sensor technologies can in real life) and allowing for various re-representations of that data.

Supporting R3 & 4: Transformation

Levels 3 and 4 build on the processes of levels 0-2 where the resources available for reflection are engaged with at

deep levels. For example seeing from multiple perspectives (discussed as a technique to encourage R2) can also lead to a challenging of original assumptions or interpretations of data as reflectors question and consider alternative explanations and hypotheses. Challenging of original assumptions can in turn lead to a fundamental change in understanding, which can lead in practice settings to a change in that practice. Because these levels are much more about what people are doing with the information for change and transformation, i.e., more as internal processes, we will not include any further specific technology examples here. This is not to say that technology will not have a role to play in the actual practice of transformation but that arguably the main role for technology is in supporting the foundational resources and processes of reflection.

EXEMPLAR CASE: SENSECAM

To illustrate more clearly how technology can be designed to support reflection in practice, encouraging a whole range of behaviours at different levels simultaneously, we present here a case study of a technology, SenseCam, that was not explicitly designed to support reflection but was used to support trainee teachers' reflection on practice (Fleck and Fitzpatrick, 2009).

SenseCam is a wearable digital camera augmented with a number of sensors, such as light, sound and movement, which automatically trigger it to take photographs as it is worn around the user's neck somewhat like a pendant (see Hodges et al., 2006). When worn by trainee teachers as they teach a lesson, SenseCam provides a photographic record of that lesson which can then form the basis for returning to the lesson experience in order to reflect upon it. The hope is this will enable the trainees to learn from this experience and ultimately become better teachers. In (Fleck, 2008) and (Fleck and Fitzpatrick, 2009) we describe how SenseCam images were used in a variety of settings to support this reflection. For example, some teachers looked through images alone and used them to self-reflect on their lessons, whilst others reflected alongside peers or with support from a more experienced teacher as mentor.

Across these settings, the teachers' SenseCam recordings of their lessons were able to support their reflection by making use of a number of the techniques described in the section above. Primarily, images provided a record of events for the teachers to return to (R0), and formed the basis for discussion with a peer or mentor, with the opportunity to provide explanations and justifications for observed events (R1). Secondly, the images were reported to support a number of the aspects of 'seeing from another perspective' (R2) described above. For example the images recorded and reminded participants of things they had forgotten or had not noticed at the time, and allowed them to notice patterns in their behaviour which were only observable through taking a step back from immediate events. In addition, some participants placed a SenseCam in the room allowing them to capture things they literally could not see at the time (for example what went on behind their backs). Further, when reflection occurred between two or more people, as images were discussed, participants shared their different perspectives on events in the classroom. In some cases, such mechanisms led to higher levels of reflection including the challenging of original assumptions and a fundamental change in understanding (R3). These observations highlight that there is often no clear distinction between a technique for encouraging one aspect of reflection and a technique for encouraging another: and there is a certain circularity to it all with *higher levels of reflection following from lower levels by making use of the same techniques*.

Also, one important way in which the various settings SenseCam was explored in differed from each other was in the amount of *structure and support* given to the reflectors as they looked through and discussed the captured images. Mentors were able to use the images as a prompt to drive the trainees thinking through the use of reflective questioning, and in general these sessions saw higher levels of reflection reached than the more open-ended self-reflection sessions. Following from this, future trainee teachers' reflection with SenseCam may be improved with the implementation of a set of guidelines for its use, particularly a clear framework for structuring discussion around images. Looking at other techniques we have suggested, it is also possible that making some of the sensor data captured available alongside images may further enable participants to 'see more', which may in turn encourage further reflection.

DESIGNING FOR REFLECTION

In this paper we set out to synthesize and build upon the diverse work in the various literatures around reflection in order that we may better inform design. A review of the HCI literature highlights the fuzziness in which the term 'reflection' is used within the HCI community as it begins to embrace the concept of reflection as a new design goal in its own right. However, there is also fuzziness in the definitions of reflection in the broader literature. Therefore, rather than trying to precisely define reflection, we have focused instead on drawing out a number of aspects - including purposes and conditions for and types of activities and behaviours associated with - reflection, which we suggest is a more useful approach for HCI and design purposes. Based on these we have suggested various roles for technology in supporting reflection.

We now go on to draw from these observations a set of questions (guidelines) that can support HCI designers in thinking about designing for reflection.

1. What is the purpose for the reflection?

An observation made of many of the papers in Sas and Dix's workshop on designing for reflection on experience (2009) was that the authors did not convey a clear purpose for reflection, rather phrases such as 'the analysis of our identity' (Byrne and Jones in Sas & Dix, 2009) were used. This is perhaps fine: Moon does list 'other outcomes that might be unexpected' (1999, p98) as one of her purposes for reflection, and often the intention of art is to promote new ways of thinking and seeing without

making any claims as to what this may lead to (e.g. Gaver et al., 2003; Weiser & Seely Brown, 1997). However, key to providing a structure for reflection is being aware of the purpose of that reflection and guiding thinking to that end: having no clear purpose then might limit technology only to (providing time for and) provoking reflection - not to structuring and encouraging it. In this way opportunities for reflection may be lost.

2. What reflective behaviours do you want to encourage? Which technologies and techniques can support these behaviours?

With a clear purpose for reflection, it becomes easier to identify types of behaviours or thought associated with that purpose (i.e. those aspects outlined in the 'levels of reflection' framework). The next step then is to identify techniques (and technologies) for encouraging these behaviours: either by considering which techniques an available technology can support, or by identifying new technologies for a particular technique.

3. Are the conditions for reflection (time, structure, encouragment) being met?

With the exception of the techniques which make use of reflective questioning, most of the technology opportunities we have discussed could be considered as techniques for *enabling* reflection by making material available for reflection and sometimes suggesting links that could be made. In our case study too, the technology primarily provided a record of events that formed the basis of reflection (which was then encouraged through discussion with others and guided and supported by experts). We suggest then that it is not just the technology that needs to be designed to promote good reflection: it is the whole framework and structure within which the technology is used. As we discussed earlier, reflection requires time, benefits from guidance or support, and in many situations needs to be encouraged. Some of these aspects may not be achievable by technology alone.

CONCLUSION

In this paper we have highlighted the fuzziness in which the term 'reflection' is used within the HCI community as it begins to embrace the concept of reflection on experience as a new design goal in its own right. As a resource for thinking about designing for reflection, we have presented a framework which encompasses a number of aspects of reflection synthesized from existing literature. We have then used this to illustrate how technology has been and could be used to support reflection, concluding with a set of guiding questions for designers intending to do this in the future. This should be considered a theoretical starting point for those interested in designing for reflection – especially in situations such as reflective practice where there is a clear purpose for reflection. As noted previously though, there can be a certain circularity in the way reflection occurs: higher levels of reflection often follow from lower levels by making use of the same techniques. It is worth reminding ourselves that in all situations, the technologies and techniques can provide only the resources and support the conditions for reflection, but it is ultimately people who do the reflection.

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