Designing for embodied being-in-the-world

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Designing for Embodied Being-in-the-World: Two Cases, Seven Principles and One Framework

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ABSTRACT

How may we design coherent, physical-digital hybrid artifacts as meaningful, mediating elements in a persons' embodied 'Being-in-the-World? We explore this question through two cases, one of designing for a person with autism spectrum disorder and one for people with dementia. We reflected in an iterative way on how the designs evolved, and on how our theoretical lens, grounded in embodied theory, helped to shape the designs. In the final round of reflection, we compared both case studies, looking for overall commonalities, which formed the basis for the resulting design framework that we introduce in this paper. The framework consists of seven principles, of which three support embodied activity in the here-and-now, three support developmental processes over a longer time-scale, and finally the idea of a reflective process to connect them.

Author Keywords

Embodied Being-in-the-World; assistive technology; empowerment; tangible interaction; ubiquitous computing

ACM Classification Keywords

H.5.2. Information interfaces and presentation (e.g., HCI): Theory & Methods; K.4.2. Computers and society: Assistive technologies for persons with disabilities

INTRODUCTION

Over the past years we have explored the value of Embodied theories for design [16], with embodied cognition [10, 52], ecological psychology [24], phenomenology [43, 19, 55], situated cognition [53, 25, 47] and pragmatism as our main sources [15, 49]. Especially concerning 'physical-digital hybrids', as e.g. in Tangible Interaction, Augmented Reality, Ubiquitous- and Wearable computing, we see merit in taking an Embodied approach (and with us [18; 37, 54, 41]). Physical-digital hybrids (hereafter: 'hybrids') by nature invite a rethinking of the traditional distinction between 'digital' and 'physical'. Such rethinking may benefit from

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Figure 1. Opening up traditional Cartesian splits reveals a design space focused on 'Embodied Being-in-the-World'

grounding in appropriate theory. Embodied theories may help designers in understanding how in the concrete interaction between a person and a technological artifact, the 'material' and 'immaterial' aspect are really part of one 'lived' experience.

In this paper we ask what it concretely means to design hybrids that cater such integrated experiences, and how to actually go about it in practice. Building on [16], and the design principles in [34], and by reflecting on two new case studies, we now offer a coherent design framework for designing hybrid interactive artifacts to become meaningful, mediating elements in what phenomenologists call our Embodied Being-in-the-World [19;16].

BEYOND CARTESIAN SPLITS

Our proposal concerns a qualitatively different role for hybrids, one that goes beyond more conventional forms of tangible- and embodied interaction. In particular, we are not just proposing to design 'embodied' or 'tangible' *interfaces* to, for example, digital personal applications, or to digital social- or communication applications. Neither is our take on embodiment to be understood as designing technologies in support of the *physical body*, such as for example a responsive leg-prosthesis. And neither do we mean

intelligent physical environments that respond to our physical bodies' location or movements (e.g. the room that automatically plays your favorite song when entering it).

Instead, the perspective we promote aims to overcome two, strongly related, lingering 'Cartesian' splits: 1) the separation of 'immaterial' from 'material' (c.f. the mind-body problem in philosophy [43, 19, 52]); and 2) the distinction between an (inner) person and an (outside) world (c.f. phenomenology's critique of the subject-object distinction in science [43])¹. We plotted these splits as axes in Figure 1 resulting in a conceptual space with four quadrants. By and large, the quadrants represent the four kinds of technology mentioned earlier: personal digital applications in the top-left, social communication applications in the top-right, physical body support in the bottom-left, and intelligent spaces in the bottom-right.

The bulk of interactive technology today can be placed in one of these four quadrants, or, alternatively, a device may be easily split up into component parts that each occupy a quadrant. However, there are many (especially classical) tools and artifacts that seem to question this Cartesian frame. For example, the hammer [29] and the blind man's cane [43] have famously been used to argue against a strict separation between person and world, or between body and mind: the artifact is both an extension of the body as well as an object in the world, and through skillful, bodily interactions with artifacts, a world of meaning opens up for us in experience [43]. Or consider a family table. A physical platform to carry objects, but also an object mediating social coordination between people (see [23]). It makes no sense to split the table into its 'physical' or 'social' aspect: it is both, and the *way* in which the table supports physically is inherently tied into the *way* in which it mediates socially [25]. There are many examples challenging the Cartesian splits. Is our car a 'space' that we occupy, or our 'extended body'? Is a whiteboard a place to express individual thoughts, or a platform for collaborative sensemaking? Is a roundabout an object constraining physical movement, or a social norm that actors respond to?

The TEI community has contributed both theoretically and practically to developing alternatives to the strict separation of the physical and digital [35, 33, 18, 3, 30, 54, 37, 22, 41]. In this sense we may see TEI as being critical of traditional Cartesian intuitions in HCI [22, 18]. Several researchers are developing design frameworks based on embodied interaction, all with their own specific focus, such as collaboration [32, 33] or somaesthetic design [31]. In addition to all this work, we see the necessity to develop a framework for hybrids that dives more deeply into the consequences of radically *rejecting* the Cartesian split. This is our response to 'classic' tangible interaction where the purpose of physical artifacts ('tangibles') is to *represent*

digital information [35, 3], which theoretically means *bridging* the Cartesian split, rather than actually *rejecting* it.

In Figure 1 we illustrate our approach by 'opening up' the Cartesian splits to reveal a new design space in its center, aimed explicitly and univocally at designing for a person's Embodied Being-in-the-World. As we will show in detail through analysis of two design cases, the center space contains three core aspects: Embodied skills [24], socially situated coordination [53] and our embedding in a *Lifeworld* [1]. Through ongoing reflective practice [49] these aspects develop into our personal identity, our social relations, and gradually transform our lifeworlds (Figure 4). Hybrid technologies allow for designing artifacts that support one or more of these core aspects, in effect supporting a person's Embodied Being-in-the-World.

DESIGNING FOR EMBODIED WELL-BEING

The theoretical reflections that have led to the framework are grounded in two design case studies, to which we turn now. In recent years we have sought design challenges that would in a strong and critical sense ask us to scrutinize in detail what lies in the embodied design space occupying the center of figure 1. In this paper, we do so by reflecting on two design cases, aimed at designing technology supporting everyday, routine activities of people with Autism Spectrum Disorder (Case 1) and people with Dementia (Case 2). The context and specific challenges in these projects helped us to reflect on how the theory could guide the design process and the designs. One driving question in both projects was how to respect the lives and personally developed ways of doing of the people involved, knowing that they cannot manage without some form of care. The question "How to design technological assistance without thereby compromising the identity and authenticity of the person?" helped us to get grip on what it means to design for someone's 'being'. It raised further questions, e.g.: What could interactive technology be for people that slowly but certainly lose their cognitive and motor skills, or for people that have a completely different understanding of the world and their social interactions? What do we mean with 'empowerment' and 'self-management'? What could our world look like if autism was seen as simply another way of being in the world and not as a disorder? What could our world look like if we would design for the extreme, e.g. if we all would have dementia or we would see dementia as a blessing? Consequently, we might not focus on steering our designs towards remedy, compensation, adjustment or delay of progression of cognitive and motor impairments as is often done in interactive technology design [42; 26; 51; 38; 40], but on respecting everyone's unique embodied being in the world. Could designing for 'Embodied-being-in-the-World' (the center of Figure 1) offer a new perspective for not only these two target groups, but in the end for all of us? So, can the

¹ Actually these splits are often taken together as 'The Cartesian split'. We make no strong claims on whether it is better to talk about one or two splits; the purpose of the sketch in Figure 1 is to provide a background against

which we can introduce our alternative as one rejecting all such strict separations between mind, body, social world and physical world.

lessons learned from these challenging cases, be applied to our everyday HCI artifacts?

The aim in both cases is to *empower* people in living their own everyday lives, that is, to design artifacts that enable people to be most fully themselves in their own familiar world. The first case focuses on independent living in the home environment and the second case focusing on living respectfully and situated towards and in a care home.

CASE STUDY CONTEXT AND APPROACH

In each of the case studies we reflected in iterative fashion on the way the design evolved, how our embodied theoretical lens helped to shape this evolution, and how, in turn, the practicalities of the design challenge and context critically ‘talked back’ [49] to the theory, demanding us to be ever more precise about the theory’s contribution in making concrete design decisions. All levels of design were considered: from discussions about overall function and purpose all the way to the detailed shaping of interaction design and form-giving. Taken together, our cases explore the embodied design space both in-depth, iterating one specific design concept (MyDayLight, see below), as well as more broadly, by developing a collection of different designs (Sensuous Dementia, see below). In the final reflections we compared the two case studies by looking for overall commonalities, which formed the basis for the resulting design framework as presented below. But let us first introduce the two case studies.

CASE 1: DAILY ROUTINES AND AUTISM SPECTRUM DISORDER

Over the course of two years, in four main projects (each resulting in experienceable prototypes), 24 bachelor students and 3 master students designed for- and with Max (not his real name), a 31 year-old high functioning person with Autism Spectrum Disorder (ASD[27]), who lives in an independent living facility. All projects included interviews, observation, co-design activities and prototype evaluations with Max and three of his professional caretakers.

The supported living facility has the aim to help Max manage his own life to the greatest extent possible. This is challenging mostly when Max is free to make his own plans (e.g. on a day off). Max is easily distracted by recurring worries [7] or becomes preoccupied with ‘irrelevant’ details [2]. Planned tasks remain unfinished, leading to frustration and a sense of personal failure. Unfinished business in his apartment itself may be a source of new distractions, creating a feedback loop where the chaos in his head becomes reflected in the chaos in his apartment and vice versa. With Max and his caregivers, we developed MyDayLight: a ubiquitous, interactive light system that helps in structuring daily activities (Figure 2). It works as follows. If Max wants to do the dishes each day at 11AM, he plans this task in a calendar on a tablet and assigns it to a tangible ‘Highlight’ (for example, one that Max placed in the kitchen). At 11AM, the kitchen Highlight will light up. This cues Max’s attention to the kitchen, prompting him to do the dishes. Once the time

is up, the Highlight fades out. With each planned task, another light-cue in an associated physical location lights up.

Figure 2. MYDAYLIGHT (fourth prototype), including the Highlight and the Reflector overview

Figure 3. Sensuous Dementia: *For the time being* (upper left), *The Richness of Tea* (upper right), *Warm Place* (lower left) and *Orchestra of Senses* (lower right)

Max is free to place Highlights where he wants, creating a visual web ‘highlighting’ task-relevant areas in his apartment. By turning a Highlight, where turn-right means ‘I am feeling ok’ and turn-left means ‘I am not feeling ok’, a visual pattern emerges in the Reflector overview (Figure 2) to help Max and his caregiver to reflect on the day, learn, and make new plans.

CASE 2: DAILY ROUTINES AND DEMENTIA

In the first phase (2,5 months) of this 3-year Transformative Homes for Sensuous Dementia project, 19 ID Master students under guidance of 10 creative experts developed 4 experienceable prototypes of situations in a transformative home with people with dementia and their (formal and informal) caregivers (Figure 3). Designs were iteratively developed and evaluated after 8 weeks during an exhibition with 50 external stakeholders (care institutions, insurance companies, home automation industry, design firms, citizens). The designs approach dementia from the experience in the here and now, exploring the uncultivated

space of using people’s sensorial skills to empower them, given that cognitive and motor skills appear to be deteriorating over time [8, 44, 56]. The approach ran opposite to many technologies designed for dementia, as we did not try to revive memory and reminiscence, or delay deterioration of cognitive skills [42, 26, 51].

Most of the designs focus on the care home, but the first concept can also be used in a regular home. The four concepts were prototyped for experience, though sometimes simplified for technical reasons. They are (see Figure 3):

- 1) *For the Time Being*: An integrated “clock” in the house that does not tell time, but shows/offers valuable objects via a spotlight, inviting to do the related activities at a specific time.
- 2) *The Richness of Tea*: A new tea ritual where caregivers and people with dementia enjoy making tea together and take time for each other. The orientation of the spotlight and of the rotating display can be adjusted according to the stage of the tea ritual.
- 3) *Warm Place*: A playful way to use heating spots in the care home, i.e. an interactive heat lamp that adjusts its heights in relation the place of ones hands, and a warm tactile rice-box, to create sensory moments of comfort in interaction with others.
- 4) *Orchestra of Senses*: a set of playful instruments that use smell, touch, sight and sound to raise the appetite, forming an embodied activity bridging to actual dinner.

DESIGNING FOR EMBODIED-BEING-IN-THE-WORLD: A FRAMEWORK

The main insights from the two projects formed the basis for our design framework, illustrated in figure 4. We reflected both on the design process itself, as on the use evaluations. For MyDayLight, use evaluations are primarily based on an in-depth, one week long ethnographic study with a fully working prototype (the third version) placed in Max’ home, followed by daily visits with situated interviews, observations of all daily client-caregiver meetings, and a final group interview with Max, his parents, and one caregiver. Insights from the Sensuous Dementia projects are based on the qualitative feedback from the 50 stakeholders present at the interactive exhibition, and on 5 user tests done in care homes with the Richness of Tea.

We distinguish between how artifacts support embodied activity in the here-and-now, and how they may spur a developmental process over a longer time-scale. While we present the framework as a list of separate principles, we emphasize that these are strongly interrelated: e.g., to engage in social coordination is part of our skillful dealing with the world, and skillful dealing is always already socially situated. The principles we list here are meant to be integrated through design into a complete system in context, that will give rise to a unified, lived experience.

Embodied Interactions in the here-and-now

We first discuss embodied interaction in the here-and-now:

Figure 4. A design framework:
Designing for Embodied Being-in-the-World

1. Sustaining Skills

Skillful action, mediated by the use of tools, is something we do with our whole body. Tools do not only produce a desired ‘output’ behavior – the ultimate effect emerges from the way a person skillfully uses the tool. Skill is ‘know-how’ – it is acting intelligently, though in an embodied way, enabling a person to deal successfully with circumstances, without a detached ‘cognitive’ phase of observing, interpreting, internal processing and action-planning. In acting skillfully there is no separation, nor a linear ordering, of action and perception: they unfold in parallel and become *coupled*, and the tool functions as a binding element this coupling process [19].

Our designs contain aspects of tools supporting skills, i.e., mediating and sustaining action-perception couplings. For example MyDayLight does not provide ‘information messages’ to the user that need to be interpreted in order to decide what to do. Instead, the light cues, situated in a context, help the user to attend to relevant aspects of that context, upon which one ‘sees what needs to be done’. The design challenge became to find how technology would mediate in the evolution of a person’s skill in utilizing the familiar structure ones’ apartment in order to guide appropriate action. The third prototype used for testing contained a regular Google Calendar for setting time and day for each lamp. However Max experienced difficulties in setting the *exact time* for each task: at various moments he refused to set a task, because, in his words, he didn’t know *for sure* that he would actually want to do that task *at that precise time*, the next day. Google Calendar actually biased the interaction again towards thinking of the device as a tool for precise planning of future events, rather than as setting a rough-and-ready *cue* that would guide, but not specify, the actual time and manner in which the task would be done.

For the Time Being offers personally relevant tools needed to maintain certain skills and interests. It is both the offering of the tool as a reminder of the activity, as well as the way of offering the tool that addresses action-perception loop. So instead of reminding a person to read a book or do her embroidery via a calendar, time sheet or verbally, For the

Time Being offers the tools directly to the person by putting them into the spot light. For the Time Being uses the affordances of the tools and offers the activity itself.

2. Scaffolding Social Coordination

Whatever we do, we do it against the background of having to negotiate our own position over and against other human beings in our social world, and our actions, decisions and the way we make sense of things in action is socially contextualized [39, 53, 25]. The manipulation of physical objects (which relates to skills in 1.), plays a crucial part in this ongoing ‘social coordination’. People use the public world of objects and artifacts, including their own physical bodies, as *scaffolds* [13] for participatory sensemaking [36].

The Richness of Tea includes a table full of scaffolds for making and drinking tea. The lamp in the middle can be operated by the host (caregiver, family member, ...) and successively highlights the four activities related to the ritual (exploring and selecting the ingredients; crushing and mixing the tea leaves; playing with and selecting sugar; pouring water and drinking the tea). By turning the display, the person with dementia and the host go through the journey of making and drinking tea, while enjoying the richness of the sensorial sensations of interacting with the ingredients. The design and the ritual create a physical and social place for taking time for each other, as the caregivers indicated during the 5 user tests performed in care homes. Currently, there is place nor time in care homes to evoke attentive, empathic relaxation with inhabitants. So, the scaffolds are used in the moment to make meaning together.

We observed how Max and his caregivers were together discussing how to program the lamp as part of their regular daily meeting. We learned that these talks were not purely instrumental to programming the lamp but also functioned to share mutual perspectives on ‘what would be the right thing to do’ – which in effect meant a process of bringing together Max’s first-person experience, and the caregivers’ professional, third-person perspective, on Max and his ASD challenges. This is why we reframed the graphical user interface on the tablet to be not just a representation of task plans – but a REFLECTOR instead: a shared space for a person with ASD and his caregiver, to look at, point at, refer to, in order to collaboratively make sense of the current state of affairs, and how to improve it.

Whenever we engage in action-perception cycles with a physical object, this object is always already socially situated. So, when a person sees a MyDayLight light becoming active in the kitchen, he may feel the need to do the dishes, but this need always includes some sense of what it means to do those dishes *in relation to others*, for example in relation to the care-giver with which we had discussed the plan to do the dishes the day before. So the scaffolds are used for looking back at moments of social interaction.

When looking at For the Time Being, the rotating platform /cabinet offers an opportunity for the family or caregivers to

suggest activities. So, social coordination between the care-taker and (informal) care-giver is facilitated by the scaffolds placed at the platform. These activities can be activities for the person with dementia, but also for social activities, e.g. placing cups for drinking tea together, placing a book for reading a story for the person with dementia, or placing the telephone to make a phone call with friends or family members. So, the scaffolds are used for anticipating social interaction.

3. Embedding in the Lifeworld

The physical- as well as social world that people inhabit we call the ‘lifeworld’ [50, 1]. People do not act in the void, they do so against a meaningful background of things and people that forms a ‘context-of-practice’ [39]. Because lifeworlds co-evolve with our skills and routines, the things in our lifeworlds are always already meaningful to us. Thus, within the lifeworld things pop up as relevant to our current activity, and by acting in the world we leave traces in the world that we may later encounter and think with.

Orchestra of Senses is developed for people with dementia living in care homes. They often get ready-made food presented in front of them at a fixed time slot, but which might not be aligned with their appetite or expectations, since their connection with their lifeworld is often distorted. Moreover, there is often no perceivable preparation phase; by taking away the process of cooking, dementia patients tend to forget to eat and they tend to lose their appetite [28]. Orchestra of Senses tries to restore this relation by offering a ritual to recreate a connection with their dinner. By playing with the set of sensorial instruments their olfactible, haptic, visual and auditory senses are triggered towards dining, thus aiming to raise their appetite and restoring part of the relationship with their lifeworld.

In MyDayLight the lamps by themselves convey little information – instead what they do is to highlight the particular organization of already meaningful things in the users’ own apartment. These things are meaningful cues because the environment has developed alongside with the skills, routines and habits of the person: this is *his* environment. In case of a person with ASD (and to some extent for all of us), the cues we perceive do not always coincide with what we had rationally planned to do. In this case a person becomes distracted and defocused. Instead of ‘overruling’ bottom up triggers by providing explicit notifications on a screen, MyDayLight functions as a (self-developed) situated filter, drawing attention to those aspects in the user’s own lifeworld that *help* rather than *confuse*.

Long-term developments

The second set of principles that make up our framework deals with long-term effects of interacting with physical-digital hybrids in embodied ways. While the principles below are grounded in theoretical reflections on the design evolution, they are in some sense more speculative, as working prototypes have not been tested for longer than one week, and the transformative effects we propose would

typically take weeks, months, or even years to evolve, as the artifacts are gradually appropriated within a person's daily routines and take up position within the larger physical- and social setting that makes up the lifeworld.

4. Forming and expressing identity

Skills, tools, and the lifeworld relate to identity. Exercising ones' skills, being reliant on ones' tools, in ones' familiar context, in a way means expressing who one is. Developing ones' skills, building social relations and growing a lifeworld goes hand in hand with forming an identity.[19]

Riemer and Johnston [46], conclude that much IT poses a threat to identity because it lacks the quality of what Heidegger [29] calls 'equipment':

"Use of equipment is at the heart of our human way of being, ... and constitutive of self ... [I]ndividuals express their ... identities through the equipment they use. Replacing this equipment might in the worst case equate to tearing apart one's (professional) lifeworld, one's existence, which was built on the basis of what one does and therefore how (in what way) one 'is'" [46, p.10.]

Likewise, Lave [39] argues how becoming 'knowledgeably skillful' is part of developing an identity as a member of a community [39]. This means for assistive technologies at least that the user should experience using an assistive tool as 'something I do with the tool', which then also means a way to 'express myself', rather than 'something the tool does for me' [17]. This means also to not replace existing routines and 'ways of being' with technologies based on externally defined, normative accounts of 'how things should be done' [6, 53]. In the many conversations we had with Max, using 'his' lamp clearly seemed to help him take up a more autonomous position regarding his own life – managing tasks became something that *he* was doing, rather than being a response to the caregiver's demands.

The change or loss of identity for people with dementia is still under debate, since the topic is not sufficiently explored [9] and/or there is no agreement on the process of sense of identity, since some researchers claim a disintegration of the self as the disease progresses [e.g. 14], other researchers claim that the sense of self persists [e.g. 21], and others indicate their might be two sides of sense of identity: one quite stable and the other varying over time and with experience. [20]. When taking Dreyfus' stance that 'exercising ones' skills becomes the expression of who one 'is' [19], it implies that the sense of self will be effected, especially since their cognitive and motor skills are deteriorating over time [8, 44, 56].

One of the people with dementia that participated in our study experienced a kind of sense of identity loss, since he couldn't remember to go cycling which was one of his most important hobbies; he was a cyclist and by not cycling he (sometimes) felt a great loss. Others were very attached to certain objects in their environment since they allowed them to do certain valuable activities and use their skills.

For the Time Being tried to address this sense of identity in two ways. Firstly, by offering valuable objects over the day that invite to keep using, maintaining or even developing specific skills, and thus being invited regularly to express who one is through one's skills. Secondly, For the time being can also be used to deal with the changes of skills over time, especially during the earlier phases of dementia. For the Time Being invites people with dementia in the early phases to create rituals when they still have most of their skills for the time that their skills will be challenged or deteriorate. Which skills are important for them, their life, their identity, and how would they like to incorporate them in their everyday living through For the Time Being? This way, it also makes For the Time Being a tool for reflection (see principle 7).

5. Social relationships

When people socially coordinate their activities in situ, this creates *roles* people take within communities of practice on the long run [39].

In MyDayLight the different roles that the person with ASD, caretaker and parents played were explicitly discussed. One of the aims of the project was to help, through the device, transform existing roles to ones in which people with ASD would be more autonomous in their own lives and caretakers would 'carefully coach' rather than 'take care of things'. Max actually used the system mostly to plan meetings with other people and less for daily chores. He anticipated on social implications of programming the lamp, which gave him some sense of control over the future event. For example he'd say: "For Sonja I choose a nice violet color for the couch-lamp, so I'll put her in a beautiful light when she sits there tomorrow'.

Next to the roles of people, we also looked at social relationships and attachments. Attachment may be radically embodied, and social baseline theory [45, 4] might support this premise. [5] Attachment in an embodied context can be seen through the lens of affordances as relations, in this case between two living bodies. For example, attachment can emerge and be strengthened by a person's body to provide support (e.g., softness, body heat and body trunk one can cling to) and his/her capacity to elicit the type of support needed by someone else (e.g., eliciting soft caresses and huddling or holding behaviors) [12]. Moreover, literature shows that one's health correlates with the intensity of empathy and helpfulness of the social network a person is embedded in [5]. Warm Place specifically focuses on jointly playing with the installations while stimulating body heat through the warmth of the rice and the lamp. The Richness of Tea targeted at empathy and helpfulness by affording through the tea ritual to take time for each other. Finally, For the Time Being aimed at using both physical and social affordances to trigger empathy and helpfulness. The family and caregivers can suggest activities through the objects, they can put valuable objects and potential events in the spotlight, and they can do the activities together with the

person with dementia. While the disease is advancing, this design aims at supporting attachment by keep on doing things together, especially when verbal communication is getting more troublesome.

6. Transforming the Lifeworld

In 3. we discussed how the lifeworld forms an active element in the way people perceive and act in the world. This lifeworld however itself changes as people gradually reconfigure the space they inhabit [6]. At this point we have to speculate about actual long-term outcomes. Over time, using MyDayLight the user may decide now and then to put lights in different locations, trying out, improvising, and deciding to plan new tasks, at various moments in time, up to the point the system works well with the given configuration of the apartment. In a future study, next to investigating where people put their lamps, we plan to investigate what *names* users give to the lamps, and *how many* lamps they feel they need in order to manage an activity, or set of activities. While gradually configuring the system, other elements in the apartment (furniture, tools, etc.) may also be replaced to have them ‘work better’ with the lamps (e.g. put everything that belongs to one task in the same location, [1]). The technology does not prescribe such reconfigurations nor does it create a completely new, artificial environment next to the apartment itself (as in a virtual management tool on a screen). Rather, it would catalyze a process by which a person gradually adapts his own space to whatever works best for him.

Considering dementia a gradual adaptation of the lifeworld is a necessity, as the person in question gradually changes in her capabilities due to the disease. The user test of The Richness of Tea revealed that the ritual and the scaffolds need to be adjusted over time. Whereas in the earlier phases of dementia a variety of scaffolds can stimulate sensorial pleasure and social connectedness, in the later phases it might cause confusion and dangerous behavior (e.g. burning by touching a heated tea pot, or getting confused due to too much visual stimulation), thus the table should offer less and/or different scaffolds in a later phase. Moreover, although not implemented yet, The Richness of Tea could register the interaction during a tea ritual and visualize the changes in interaction over a longer period of time in order to enable the host to adjust the ritual over time. The table could even suggest alterations regarding time or light focus based on the patterns of change.

7. Reflecting in- and on action

Finally, as the overall process by which existing couplings, between people and tools (skills), between people (social relations) and between people and the overall setting (lifeworlds) change, we offer the process of reflection as grounded in action. This basically pragmatist, Schönean-Deweyan process is to be contrasted with a rational, theory-based approach in which one first *thinks* about what should ideally be the right sort of behavior, then executes it, and then afterwards evaluates whether the activities conformed to the

model or not and, if not, what should be done about it. In contrast, reflective practice means that one at times temporarily steps back from an essentially *ongoing* activity, one takes a distanced perspective, one looks at what is there to be seen (which is not something one was looking for based on some previous idea) and this looking with a distance may then evolve into a ‘new way of looking at things’, which subsequently invites new sorts of actions (which may help to overcome the hurdles that emerged from the old way of looking).

In MyDayLight the process of reflection on action was quite explicitly implemented by creating a ‘reflector’ interface that should help caretaker and person with ASD to reflect on the day and on that basis discuss future actions. This design move itself instantiated a reframing of the original idea of the tablet interface as a calendar in which to plan future actions as just one aspect of a larger process that is focused on *reflection*: on taking a step back and looking at how things are going. From our user evaluations it became apparent that in this reflection the exact time at which a task was executed, and its duration, are actually much less important than is the *mood* experienced during execution of tasks. In other words, in self-management may be more important to focus on how one feels, than on whether one is actually performing according to plan. This is why in the final prototype we included the option turning the lamp to the left or right, thereby indicating a positive or negative mood. This action itself already invites a ‘mini-moment of reflection’. It also adds to a gradually emerging visual pattern of colored dots in the calendar, to be used for looking back on the day later on.

For the Time Being incorporated reflection on action in a fairly implicit way. Initially, the platform and objects can work as a reflection mechanism for caretaker and caregivers, but over time it slowly but certainly becomes a reflection mechanism for the caregivers. There is not a separate visualization to stimulate reflection on action as was designed for MyDayLight, but the reflection goes initially through the change of scaffolds over time: the amount and kinds of objects that change. The platform could register what has been used and in which way, and leave traces over time on the platform when put in reflection mode.

DISCUSSION

A framework for reframing

Working from an Embodied perspective means a repeated revisiting of implicit ‘mainstream’ assumptions, at various levels of detail, each time again reframing the design challenge. For example, in MyDayLight, we initially considered *informing* the user on what to do, e.g. using icons in the tablet interface, text-messages on the lamps, and so on. Taking an embodied perspective however helped us in the later prototypes to emphasize the users’ own skills, and rely on the meaning present in the social- and physical context, instead of predetermining meanings in designed representations.

A similar shift happened in the Sensuous Dementia project in hindsight, when evaluating with users during the exhibition. For example, the students designing For the Time Being did not initially distinguish between actual use objects and placeholder/representations of such objects. A mini chair (a representation) was used as well as a real book and someone's embroidery (actual products), while actual use objects of course have very different immediate affordances for action than its representations. Objects were also placed on every "hour" of the platform, which made for a total of 12. At the exhibition it became clear that this configuration ignored social coordination in actual practices, where meaning is created based on the pace of the day, the needs and interest of the person with dementia, relationships and activities with caregivers etc., having no intrinsic relation to the structure of a clock face.

One of the reasons for developing this framework is to make such considerations explicit and open for reflection to students of design, such that reframing becomes possible. The aim is to question possible Cartesian presuppositions and offer an embodied alternative. For example, the framework would have invited the students to think about objects and activities that can not be placed on a platform, such as the bike of the cyclist. In similar fashion the framework may also help health-care organizations and professional health-tech designers to become sensitive to alternative mediating roles for assistive technology that fits a person's lifeworld and skills and thus may less likely to be abandoned in practice [11]. For example, it may help health care organizations to focus less on wanting to 'control the situation', and instead 'facilitate' people's means for maintaining self-control.

What we mean when we talk about embodiment

The framework we present can be used by designers exploring ways to connect more deeply and intimately to people's situated, embodied practices. However it also invites to go beyond other known uses of the term 'embodiment' in design. Some of these other views have perhaps been more readily applied in tangible- and embodied interaction design in the past, as they typically demand a less radical departure from the Cartesian frame we introduced in the introduction (Figure 1). Here, we briefly contrast some of these approaches to our own.

First, our framework has little to do with the superficial interpretation of 'embodied' as meaning just anything involving physical bodies. Interactive bracelets, -clothes, even prostheses or implants are not (necessarily) 'Embodied' in our interpretation. Consider for example our embedding in the *lifeworld*, which deals with the social- and physical *environment* much more than with our *body*.

Second, we move beyond the popular notion of *distributed cognition* as well [13,16]. Our framework targets a level of person-world engagement that comes 'prior' to the evolved practice of creating and using 'external representations'. External representations are of course also part of our

embodied practices, and such elements are also part of our designs. But our framework focuses first and foremost on supporting skillful couplings and social coordination, which in fact form the ground upon which something like 'using representations' becomes possible at all [53]. We invite designers to connect to this deeper level of Embodiment.

Third, the previous point entails we will ignore the use of bodily *metaphors* to *re-present* digital information [3; 35, 16]; or re-presenting in artifacts metaphors of the human body [48]. All of this may be tremendously important for designing information representations, but our intention is not to design information representations: our intention is to design for Embodied Being-in-the-World, which concerns skills, social coordination and action-based reflection.

Fourth: neither do we propose to design artifacts that enforce specific behaviors, by clever use of constraints and affordances. We carefully design to cater embodied practices, yet our systems always remain open, because the artifact must be *incorporated*, which happens in use. In our cases, this also meant not to aim at technology taking over deteriorating cognitive skills of people with dementia, nor to create technology that would specify or train specific desired behaviors to people with ASD. An anecdote from the MyDayLight project serves to illustrate this. When the first prototype was presented, the caretaker suggested enthusiastically to Max to take the 'task-list' (an existing paper list to-do list that the caregiver had earlier created for Max), and 'program it into the lamp'. 'Absolutely not', Max replied, 'we are not going to put *your* task-list into *my* lamp'. This reply showed to us that the product, even in this early design phase, started to help Max to take up a new, more autonomous position, transforming the social relation.

As a last remark, our framework is not meant to critique other embodied approaches as being invalid accounts, for Embodied Theory is itself an umbrella term for many related, but also often fiercely discussed notions. What we intend to show with these studies is that there is more to embodiment than designing tangible metaphors, or to distribute digital information in a physical space, and that 'tangible', 'wearable' or 'ubiquitous' design does not *necessarily* mean a design for Embodied Being-in-the World. Of course, we are not alone in this initiative; there are several examples of strong embodied designs at the various TEI conferences. But we do hope to offer, to those who wish to take this path, seven concrete principles in one coherent framework, to help designers appreciate what a strong sense of Embodiment may offer, and to provide inspiration and guidance during their design process.

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